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13. ABSTRACT (Maximum 200 words)

This LEAP Supplemental Environmental Assessment modifies previously planned LEAP Test Programs which demonstrate and evaluate advanced technologies to determine whether an exoatmospheric interceptor system is feasible. All potentially significant impacts from modifications to previous LEAP Test Programs will be precluded by implementing standard engineering practices, planned safety measures, and the mitigations measures in the LEAP Test Program, Environmental Assessment (July, 1991), and the USAKA EIS.

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Supplemental
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Assessment

Lightweight Exoatmospheric Projectile (LEAP) Test Program

Strategic Defense
Initiative Organization

June 1992

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Cover Sheet

Responsible Agency Strategic Defense Initiative Organization (SDIO)

Cooperating Agencies U.S. Army Strategic Defense Command, USA

Proposed Action Modifications to the Lightweight Exoatmospheric Projectile (LEAP) Test Program

Responsible Individual Crate J. Spears
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Washington, D.C. 20301-7100

Designation Environmental Assessment (EA)

Abstract

The proposed action is to modify previously planned Lightweight Exoatmospheric Projectile (LEAP) Test Program activities (LEAP EA, July 1991, Ref # 32) at White Sands Missile Range (WSMR), New Mexico; Kwajalein Missile Range (KMR), U.S. Army Kwajalein Atoll (USAKA); and Wake Island. The proposed action includes modifications of flight trajectories for LEAP flights 3, 5, and 6. Two additional flights, LEAP-X and LEAP-7 have been added to the program. LEAP-X is a single rocket test flight from KMR and LEAP-7 is a two-rocket test flight from KMR and Wake Island. Component/assembly ground tests will take place at Orbital Sciences Corporation (OSC), Space Data Division (SDD), Chandler, Arizona; Phillips Laboratory, Edwards Air Force Base, California; Rocketdyne Division of Rockwell International; Boeing Aerospace and Electronics, Kent, Washington; Hughes Aircraft Corporation, Missile Systems Group, Canoga Park, California; Aerojet, Sacramento, California; and Thiokol Corporation, Elkton, Maryland.

The proposed action has been analyzed in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 CFR Parts 1500 - 1508), and U.S. Department of Defense (DoD) Directive 6050.1. The analyses in the EA illustrate that no potentially significant impacts to the environment are likely to occur as a result of the proposed modifications to the LEAP Test Program.

Availability Unclassified Available June 15, 1992.

Summary

Summary

The Strategic Defense Initiative Organization (SDIO) was established to plan, organize, and direct research and testing of technologies applicable to a Strategic Defense System (SDS) of ballistic missile defense. The research activities are collectively known as the Strategic Defense Initiative (SDI).

The LEAP Test Program was established to demonstrate and evaluate advanced technologies to determine whether an exoatmospheric interceptor system is feasible. To reach this determination, the LEAP program office at SDIO has established a program of design, fabrication, ground testing, and flight testing of potential technologies to meet program goals. SDIO prepared an environmental assessment of the LEAP Test Program which resulted in a FONSI in July of 1991. SDIO has identified a need to modify the LEAP Test Program.

Originally, the LEAP program consisted of six test flights. The first four flights were planned to occur at White Sands Missile Range (WSMR), New Mexico. Three of the test flights are single-rocket launches. The fourth WSMR test flight is a two-rocket launch. Two of the test flights, LEAP-5 and LEAP-6, are planned from Kwajalein Missile Range (KMR), U.S. Army Kwajalein Atoll (USAKA) and Wake Island. The test flights are two-rocket launches with the LEAP Launch Vehicle launched from KMR and the Target Vehicle launched from Wake Island.

The proposed action is to modify previously planned LEAP Test Program activities. Since July of 1991, modifications have been made to the original program. These modifications include:

- Two minor changes have been made to the LEAP-3 test flight at WSMR. First, the test will incorporate a solid divert propelled LEAP projectile (rather than the hypergolic propellants as originally planned). Second, the flight trajectory has been modified to emulate the trajectories for LEAP-1 and LEAP-2;

- LEAP launches at Meck Island at KMR, in USAKA are now to occur from the HEDI Launch Facility on the southern portion of Launch Hill, rather than the ERIS site as previously planned;

- An additional launch, LEAP-X, is planned to occur at KMR. The flight test is a single-rocket launch from Meck Island;

- The Advanced Liquid Axial Stage (ALAS) liquid propellant rocket motor has been added as the LEAP axial propulsion system for the LEAP-X and LEAP-6 flights at KMR. The system will include the use of chlorine pentafluoride (ClF_5) as the liquid oxidizer;

- An additional launch, LEAP-7, is planned to occur at KMR. The test flight is a two-rocket launch from KMR and Wake Island;

- The Advanced Solid Axial Stage (ASAS) solid propellant rocket motor has been added as the LEAP projectile propulsion system for the LEAP-7 flight.

Activities to support the LEAP program are still planned to occur at the facilities identified in the LEAP EA. In addition, component assembly activities will be performed at Aerojet, Sacramento, California and Thiokol Corporation, Elkton, Maryland.

The potential for environmental impacts was determined through an analysis of modifications of, and additions to, the LEAP program and the facilities where these activities are planned to occur. All significant changes to the program occur at KMR. A summary of the environmental resources at KMR is presented in the LEAP Supplemental EA and includes: physical setting and land-use; geology and water resources; air quality; noise; biological resources; threatened and endangered species, cultural resources; infrastructure; hazardous materials and wastes; and public health and safety.

The methodology consisted of identification of potential environmental issues and a determination of potential significance. For any impacts from the proposed action that could potentially be significant, it was determined whether mitigation measures could be implemented to reduce the impacts to less than significant levels.

All potentially significant impacts from modifications to LEAP Test Program ground, preflight, and flight test activities will be precluded by implementing standard engineering practices, planned safety measures, and the mitigation measures outlined in the LEAP Test Program Environmental Assessment (July 1991), and the USAKA EIS. No potentially significant impacts are anticipated at the participating contractor facilities.

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List of Exhibits

Description of Proposed Action and Alternatives 1.0

1.0 Description of Proposed Action and Alternatives

This document presents planned program changes to the Lightweight Exoatmospheric Projectile (LEAP) test program which are planned by the Strategic Defense Initiative Organization (SDIO). The environmental effects of LEAP activities have previously been analyzed and documented in the LEAP Environmental Assessment (EA) (Ref 38). This analysis resulted in a Finding of No Significant Impact (FONSI) issued in July 1991. The LEAP EA is incorporated by reference in this document. Although the LEAP EA and FONSI resulted from a comprehensive environmental analysis of LEAP program activities, they reflected the status of LEAP flight test planning as of July 1991.

The LEAP program previously included component assembly, ground tests, pre-flight activities, and flight tests. Assembly and ground test activities were planned to occur at Space Data Division, Orbital Sciences Corporation, Chandler, Arizona; Phillips Laboratory, Edwards Air Force Base, California; Boeing Aerospace and Electronics, Kent, Washington; and Hughes Aircraft Corporation, Missile Systems Group, Canoga Park, California. Pre-flight and flight test activities were planned to occur at NASA White Sands Test Facility (WSTF), New Mexico; White Sands Missile Range (WSMR), New Mexico; Kwajalein Missile Range (KMR), United States Army Kwajalein Atoll (USAKA), Republic of the Marshall Islands; and Wake Island (Exhibit 1.1).

An analysis of six flights was presented in the LEAP EA. The LEAP-1/-2/-3 flights were single-rocket launches from Launch Complex (LC)-36 at WSMR. The LEAP-4 flight involved a two-rocket launch with the LEAP launch vehicle launched from LC-36 and the target vehicle launched from the Sulf Site at WSMR. All LEAP flights at WSMR will use the Aries I Launch Vehicle, which is a single-stage vehicle with the M56A1 Rocket Motor (which is also utilized as the Minuteman 1 Second Stage Rocket Motor). The LEAP-5/-6 flights involved two-rocket launches from USAKA and Wake Island. All LEAP flights from KMR will use the Aries II Launch Vehicle, which is a two-stage launch vehicle. The first stage is an M56A1 Rocket Motor and the second stage is an M57A1 (the M57A1 is also used as the Minuteman 1 Third Stage Rocket Motor). All LEAP Target flights from Wake Island will use the Castor IVA Commercial Launch Vehicle, which is a two-stage launch vehicle. The first stage is a Thiokol manufactured Castor IVA rocket motor (a commercial rocket motor in widespread use). The second stage is a Orbus-1 rocket motor (a solid propellant rocket motor used both for commercial and military launch vehicles).

LEAP-5/-6 were originally planned to be launched from the existing ERIS silo on the northern portion of Launch Hill on Meck Island at USAKA. Liquid propellant fueling of the LEAP Space Test Projectiles (STP) involved nitrogen tetroxide (N_2O_4) as the oxidizer, and either hydrazine (N_2H_4) or monomethylhydrazine (MMH) as the fuels.

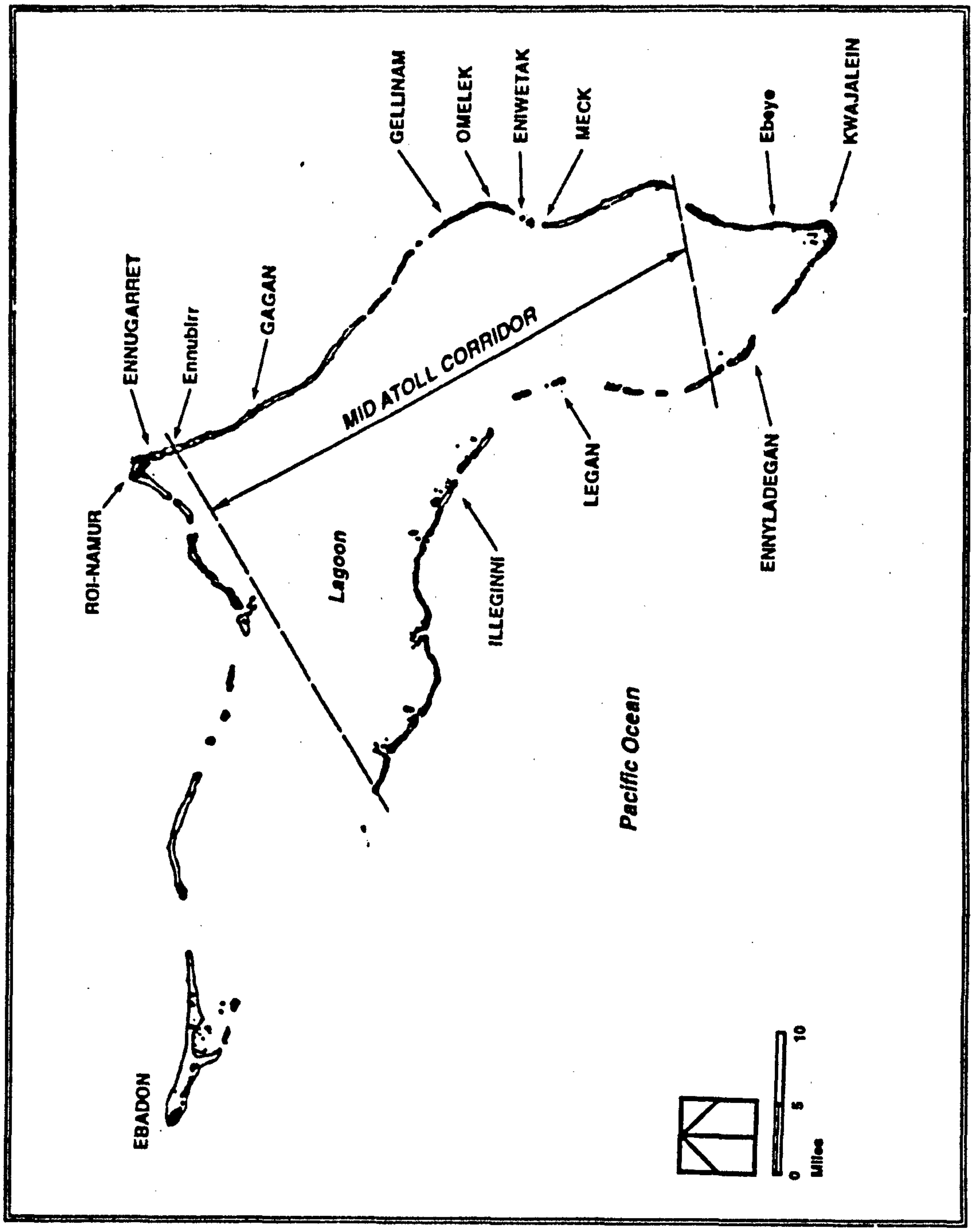

Exhibit 1.1: Kwajalein Atoll

1.1 Purpose and Need

As identified in the LEAP EA, the purpose of the LEAP Test Program is to design, develop, and demonstrate the capability of a miniaturized, lightweight projectile to intercept targets in the exoatmospheric region. Tests are required in order that the SDIO Director can make a decision regarding the effectiveness of these technologies and their role in a strategic defense system.

SDIO has identified the need for several changes to the original LEAP program. First, the trajectory for the LEAP-3 launch at WSMR must be modified to more accurately account for the trajectory of the target. Further, the program has identified the need to design, develop, and test axial propulsion motors, the ALAS and ASAS, to determine their effectiveness in achieving the aforementioned purpose of the program. The need to test the ALAS and ASAS propulsion motors has further created the need to add launches to the program to test these propulsion motors in a real flight environment.

1.2 Proposed Action

The proposed action is to initiate modifications to the LEAP Test Program to accommodate the need for development and testing of new propulsion systems. Since publication of the LEAP EA in July 1991, several modifications have been made to the program which necessitate supplemental environmental analysis and documentation and are summarized below.

- The trajectory for the LEAP-3 test flight at WSMR has been modified, and the LEAP projectile will incorporate solid divert propellants instead of hypergolics.

- LEAP launches at Meck Island (Exhibit 1.2) at USAKA are now planned from the HEDI launch facility on the southern portion of Launch Hill, rather than the ERIS site as previously planned. The change in launch location has caused a slight change in launch profiles and dispersion areas for LEAP-5 and LEAP-6

- An additional launch, LEAP-X, is planned to occur at USAKA. The flight test is a single-rocket launch from Meck Island.

- The Advanced Liquid Axial Stage (ALAS) liquid propellant rocket motor has been added as a propulsion system for the LEAP-X and LEAP-6 flights. The system will involve the use of chlorine pentafluoride (ClF_5) as the liquid oxidizer.

- An additional launch, LEAP-7, is a two-rocket launch planned to occur at USAKA (LEAP projectile vehicle) and Wake Island.

- The Advanced Solid Axial Stage (ASAS) solid propellant axial motor has been added as the axial propulsion system for the LEAP-7 test flight.

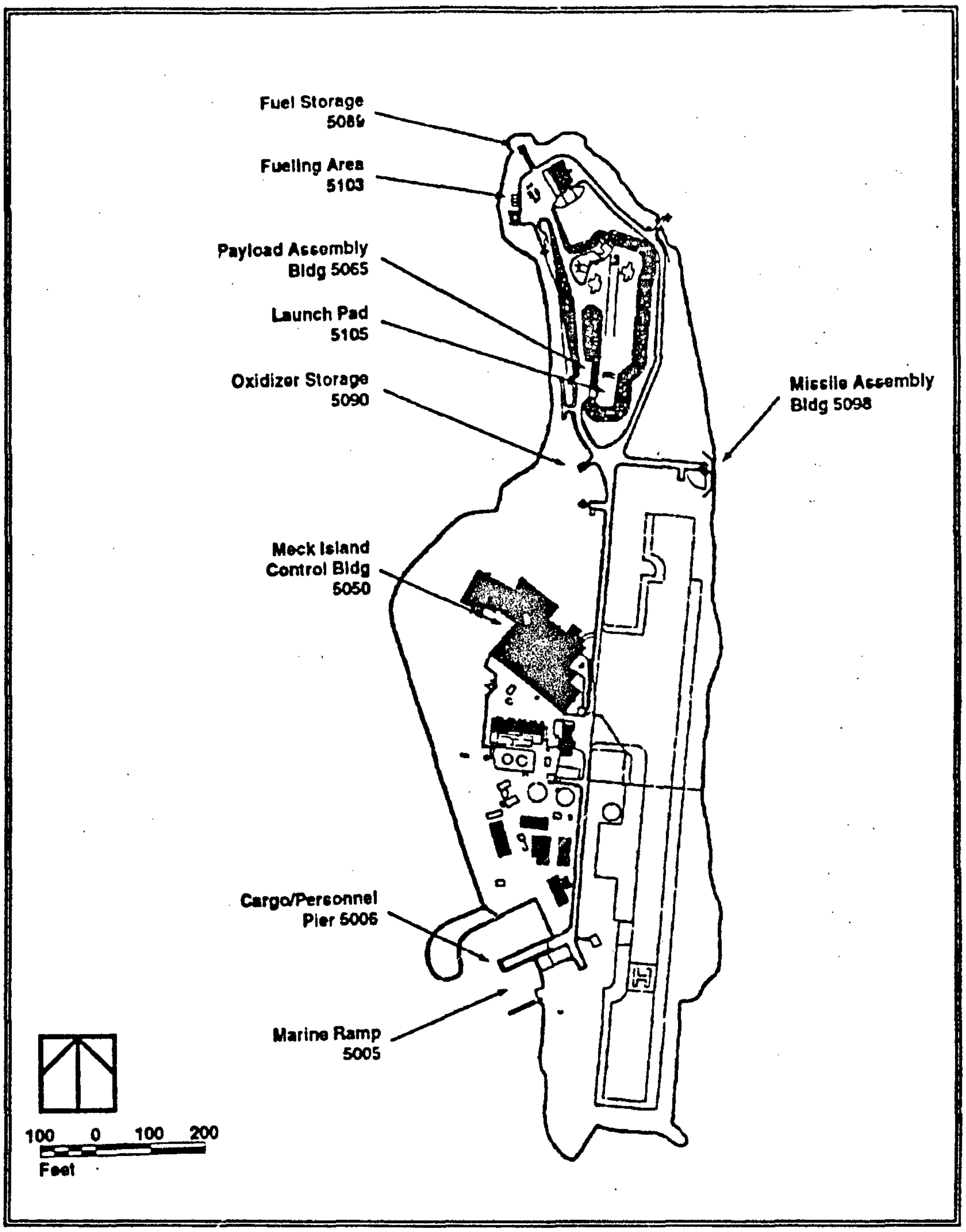

Exhibit 1.2: Meck Island

- The USNS REDSTONE will support LEAP launches at USAKA for tracking and telemetry data during flight tests.
- Telemetry equipment will be temporarily placed on Roi-Namur Island to support flight tests. This change precludes the use of equipment on Wilkes Island as identified in the LEAP EA.

1.?.1 Component Assembly / Ground Test Activities

To support the modifications to the LEAP program, various fabrication, assembly, test, and flight test activities will occur at contractor and government facilities. The following sections present an overview and the location of these activities. Exhibit 1.3 illustrates these activities, as well as the pre-flight and flight test activities discussed in Sections 1.3 and 1.4.

1.2.1.1 ALAS Propulsion Motor

The LEAP-X and LEAP-6 flight test experiments will incorporate an experimental liquid rocket motor called the Advanced Liquid Axial Stage (ALAS). The ALAS is fueled by N_2H_4 with ClF_5 as the oxidizer; helium is used for pressurization. ClF_5 has not been previously utilized in an actual flight test experiment, nor has it been previously used at Kwajalein Atoll.

The ALAS is mounted to the PMB and controlled using the PMB Attitude Control System. The ALAS is approximately 15" by 18.5" and weighs 96 pounds. The ALAS will be located underneath the PMB on LEAP-X, providing propulsion to the PMB. During the LEAP-X flight test the ALAS engine will be ignited to provide axial propulsion to the PMB. In the LEAP-6 configuration the ALAS/Interstage/STP combination will be mounted on top of the PMB, providing propulsion to the projectile.

ALAS design, analysis and testing will be performed by Aerojet Propulsion Division, a component of Aerojet Corporation, a Phillips Laboratory contractor. Aerojet will be responsible for the design, fabrication, and checkout of the ALAS ClF_5 propellant loading system.

The ALAS portion of the LEAP-X/-6 flight test experiments will employ approximately 5 additional temporary personnel at USAKA during the LEAP-X/-6 launch periods, including three persons from Aerojet and two from Phillips Laboratory (government/civilian).

ALAS Propellant - As previously identified, the ALAS will use N_2H_4 as the fuel and chlorine pentafluoride as the oxidizer. The hydrazine and monomethylhydrazine were analyzed in the LEAP EA.

Chlorine pentafluoride, ClF_5, is a hypergolic oxidizer and is sometimes referred to by the abbreviation "CPF". Combining ClF_5 with fuel, such as hydrazine, results in combustion. This combustion, when controlled by means of a nozzle attached to valves, provides propulsion for

LEAP	Locations	Activity
X,6,7	Aerojet Sacramento, California	ALAS Fabrication and Testing
7	Thiokol Corporation Elkton, Maryland	ASAS Fabrication and Testing
3	White Sands Missile Range, New Mexico	Integration and Checkout; Flight Test
X	Kwajalein Missile Range, USAKA	Integration and Checkout; Flight Test
5	Kwajalein Missile Range, USAKA and Wake Island	Integration and Checkout; Flight Test
6	Kwajalein Missile Range, USAKA and Wake Island	Integration and Checkout; Flight Test
7	Kwajalein Missile Range, USAKA and Wake Island	Integration and Checkout; Flight Test

Exhibit 1.3: LEAP Activity Profile

the ALAS rocket motor.

Ground testing of ALAS using ClF_5 and hydrazine has been performed by Aerojet Propulsion Division at their Sacramento, California test facility. Three years of testing (as of October 1, 1990) has included 128 ALAS test series, and 113 Attitude Control System (ACS) engine test series, comprising over 7,000 separate engine firings using ClF_5 and hydrazine. These tests have occurred without any safety or environmental incident (Ref #9).

During a Combined System Test (CST) of the ALAS system performed at the Aerojet facility in Sacramento, actual propellants and propellant loading hardware were used to load the ALAS system in a test bay. This procedure duplicated the procedures which will occur at Meck Island, USAKA.

1.2.1.2 ASAS Propulsion Motor

LEAP-7 flight test experiment will utilize the Advanced Solid Axial Stage (ASAS) to provide propulsion to the projectile. ASAS design and analysis will be performed by Thiokol Corporation in Elkton, Maryland. The ASAS will be mounted underneath the PMB on LEAP-7. The motor will have approximate dimensions of 12 inches in diameter by 27 inches in length. When loaded with propellant, the approximate weight of the ASAS is 128 pounds. The motor case is composed of a graphite/epoxy composite and is insulated with rubber. During the flight test, the ASAS engine will be ignited to provide axial interception.

The ASAS motor will be altitude tested at the Thiokol facility in an enclosed test firing facility. Exhaust gases during the test will be contained and recirculated through a water scrub system; thereby stripping HCl from the gas. The scrub water is sent off-site for disposal at a facility contracted to handle hazardous waste disposal. Motor shipment to Kwajalein will be in a Thiokol designed shipping container.

ASAS Propellant - The ASAS is fueled by solid propellants consisting of aluminum with ammonium perchlorate as an oxidizer. The motor will be fueled at the Thiokol facility. The propellant will be cured until expected propellant properties (rubber-like consistency) are achieved. The propellant mixture is not volatile. The propellant mixture is a DOT Class B explosive (1.3 hazard symbol). The motor, when fueled, is a DOT Rocket Motor, Class B explosive which will be shipped in accordance with Federal, state, and local regulations. A material safety data sheet for the motor is attached in Appendix A.

1.2.1.3 LEAP-X

Orbital Sciences Corporation (OSC), Space Data Division (SDD) is responsible for flight test services for the LEAP-X flight test. In that role, Space Data Division will provide mission planning, analysis, component integration, and systems engineering. Space Data Division also

serves in this role for all other LEAP launches. A more thorough discussion of these activities can be found in the LEAP EA.

Phillips Laboratory is responsible for coordinating payload ground operations, including fueling of the payloads. Phillips is also the payload manager for the mission. A more thorough description of these activities can also be found in the LEAP EA.

The ALAS propulsion motor, discussed in Section 1.3.1, will be employed on the LEAP-X flight. Aerojet activities to support the LEAP-X mission will occur at their facility in Sacramento, California as previously identified.

1.2.1.4 LEAP-7

Component assembly and ground test activities for the LEAP-7 flight test will also be coordinated by Space Data Division and Phillips Laboratory. The LEAP-7 mission includes using the Aries and Castor IVA booster configurations. These boosters, and activities to support the missions, are described in the LEAP EA. As previously described, the LEAP-7 mission will employ the ASAS propulsion motor fabricated by the Thiokol Corporation in Elkton, Maryland.

1.2.2 Pre-Flight and Test Activities

LEAP pre-flight and test activities will include transporting vehicle components, equipment, and fuels to program locations; and propellant fueling operations. Pre-flight and test activities will utilize existing structures at Meck Island. The structures to be used at Meck are identified in Exhibit 1.4).

1.2.2.1 Transportation

As identified in the LEAP EA, rocket motors will be transported by military aircraft to Kwajalein Missile Range, where they will then be shipped by barge to Meck Island. Component shipments to Wake Island remain as stated in the LEAP EA. Transportation of the hydrazine, monomethylhydrazine, and nitrogen tetroxide was covered in the LEAP EA. Planned quantities of these propellants are shown in Exhibit 1.6. Shipment of the ALAS system will be coordinated by Space Data Division of the Orbital Sciences Corporation.

A total of approximately 8.3 gallons (125 pounds) of ClF_5 will be required for the LEAP-X and LEAP-6 missions combined. The oxidizer will be shipped in 2.5 gallon stainless steel HOKE bottles (a DOT approved stainless steel handling and pressurization container which has been used for approximately five years to transport ClF_5 at Aerojet). The HOKE bottles are pressure rated at 1800 pounds per square inch. The bottles will be filled with approximately 1 gallon of ClF_5. The only pressure in the container is the vapor pressure of ClF_5, which follows almost directly the temperature of the product (i.e., on an 80 degree F day, the vapor pressure will be approximately 80 pounds per square inch).

Facility	LEAP Use
5098	LEAP MAB
5065	LEAP PAB
5064	CG/MOI Control, Computer
5050	MICB
5105	LEAP Launch Pad
5089	Liquid Fuel Storage
5090	Liquid Oxidizer Storage
5019	Equip. and Material Storage
5006/5	Cargo Dock / Ramp
5103	Liquid Fueling Area

Exhibit 1.4: Facilities at Meck

Shipping of ClF_5 will be coordinated by Phillips Laboratory and its support contractor Wyle Laboratories. Phillips will coordinate shipping from the continental U.S. (CONUS) to Kwajalein Missile Range for both the LEAP-X and LEAP-6 flights. Wyle Laboratories is fabricating the HOKE bottle overpack system which provides for safe transportation of the oxidizer.

Inter-CONUS Transportation - Phillips routinely ships ClF_5 in 100 pound shipments in case cylinders to Aerojet for routine testing at the facility. Aerojet will load ClF_5 in HOKE bottles at their facility, check the bottles for leaks, pack them in the overpack system, and load the overpack system on a Wyle Labs truck. Wyle will ship the container by truck to Oakland Pier 3 in Oakland, California.

CONUS to USAKA Transportation - The overpack system will be loaded on a Matson Navigation Company barge. Matson, a commercial transportation contractor who routinely provides hazardous cargo shipment to USAKA, will deliver the ClF_5 to Kwajalein by surface transportation (i.e., barge sea transport), stopping for a short period in Honolulu, Hawaii. Phillips Laboratory will be responsible for obtaining all necessary DOT permits and certifications. Existing docks at Kwajalein Island will be used during ClF_5 transportation. These facilities are in existence, no facility modifications will be required, and their present use is consistent with the proposed use for ClF_5 operations.

Kwajalein Island to Meck Island Transportation - A Phillips Laboratory representative will meet the shipment upon its arrival at Kwajalein Island dockside, and direct the movement of the ClF_5 to Meck Island. Handling of the containers will be performed by Launch Ordnance Personnel of DynCorp, Inc. The ClF_5 will be the first cargo off-loaded at the Kwajalein dock, and will immediately be placed upon a Landing Craft Utility (LCU), essentially a barge, for surface transportation to Meck Island. An existing landing area at Meck Island will be used during transportation, which will require no modifications to support the operations. KMR will provide handling, security, and safety support on arrival, transportation to, and on Meck, and suitable storage on Meck (oxidizers and fuels must be transported and stored separately).

Meck Island Storage - Upon arrival at Meck Island, the ClF_5 will be stored with N_2O_4 in the existing Oxidizer Storage Building on Meck Island, Building 5090. Rocket propellant storage and hazard compatibility groups are contained in Air Force Manual 161-30 "*Liquid Propellants*", Volume II, dated 10 April 1973. Chapter 8, Halogen Fluorides, lists ClF_5 and N_2O_4 in Storage Compatibility Group A (Ref 52).

The storage facilities will be monitored by Phillips Lab personnel on a regular basis. These procedures are governed by the range safety office at KMR. The range will provide fire and rescue services as required and support transport of residual fuels back to CONUS at the end of the program. Liquid fuels will not be disposed of on KMR.

1.2.2.2 Propellant Fueling Operations

For the LEAP-X, LEAP-5, and LEAP-6 flight test experiments, LEAP sub-systems will have to be filled with liquid propellants (Exhibit 1.5). Total liquid propellant quantities for all LEAP missions are shown in Exhibit 1.6.

The liquid propellant fueling sequence for all of these sub-systems is similar. The sequence will be conducted separately for fuel and oxidizer and follows these procedures:

1. Move liquid fuel/oxidizer (separately) in bulk container from liquid propellant storage facility to Building 5103.
2. Load fueling carts from bulk containers in Building 5103.
3. Return bulk containers to liquid propellant storage facility.
4. Load sub-system from fueling cart in Building 5103.
5. Fueled sub-system moved to PAB, MAB, or Launch Pad as applicable/or remains in 5103.
6. Return excess/un-used liquid propellant to bulk containers in Building 5103.
7. Return bulk containers to liquid propellant storage facility.
8. De-contaminate fueling carts in Building 5103.
9. Return decontaminated fuel cart to storage location (Warehouse, Building 5019).

Flight	Sub-System	Oxidizer	Fuel
LEAP X	ALAS	ClF_5	N_2H_4
LEAP 5	STP	N_2O_4	MMH
LEAP 6	ALAS	ClF_5	N_2H_4
LEAP 6	STP	N_2O_4	N_2H_4
LEAP 7	ASAS	ammonium perchlorate	Aluminum
	STP	N_2O_4	N_2H_4 or MMH

Exhibit 1.5: Sub-System Propellants

Propellant	Quantity
Hydrazine (N_2H_4)	8.3 Gallons
Monomethylhydrazine (MMH)	2 Gallons
Nitrogen Tetroxide (N_2O_4)	4 Gallons
Chlorine Pentafluoride (ClF_5)	8.3 Gallons

Exhibit 1.6: Propellant Quantities

Flight	Schedule	Payload
LEAP-3	4th quarter FY 1992	LEAP STP
LEAP-X	4th quarter FY 1992	Ultraseek / ALAS
LEAP-5	1st quarter FY 1993	LEAP STP
LEAP-6	2nd quarter FY 1993	LEAP STP
LEAP-7	2nd quarter FY 1993	LEAP STP

Exhibit 1.7: LEAP Program Schedule

No liquid propellant transfer operations will be conducted in the liquid propellant storage facilities. Both of the liquid fuels (N_2H_4 and MMH) will be concurrently stored in the liquid fuel storage facility. Both of the liquid oxidizers (ClF_5 and N_2O_4) will be concurrently stored in the liquid oxidizer storage facility. Aerojet will be responsible for loading the LEAP-X/6 Launch Vehicles with ClF_5 at the launch site.

All liquid propellant fueling operations will be performed in Building 5103. A temporary fueling shelter will be placed in 5103 to protect fueling operations from wind and salt. Once the sub-systems are fueled, they will be moved to the PAB, MAB, Launch Pad, or remain in 5103, as applicable. All fueled sub-systems are rated as "man safe" until the liquid propellant tanks are pressurized. The liquid propellant tanks will be pressurized on the launch pad at the specified time in the actual launch countdown. The high pressure Helium/Nitrogen cart will be operated in building 5065 (a remote operation) during the actual countdown.

1.2.2.3 Telemetry Equipment

LEAP telemetry data will be received at Roi-Namur Island through the use of telemetry reception equipment temporarily located on the island during the flight test experiments. Use of the equipment was addressed in the LEAP EA. The equipment will be located on a previously cleared and graded area, or concrete pad. A back-up generator will be placed on the island with the telemetry equipment. Generator operation will be of a limited duration for pre-flight testing and the actual flight tests. Monitoring by LEAP personnel will ensure proper installation, noise reduction measures, and proper fuel handling and spill remediation procedures are adhered to during operations. Four LEAP program personnel will be located on the island to operate the equipment during the flight test operations.

1.2.3 Flight Tests

Flight test activities include the construction and modification of facilities, monitoring, and control of the vehicle during flight and data retrieval. Air and water emissions associated with these flights are also discussed in this section. The modified LEAP flight test schedule is illustrated in Exhibit 1.7. As previously stated, the HEDI launch pad, 5105, will be used for LEAP launches. Control activities will occur in building 5050, the Meck Island Control Building.

The LEAP launch system consists of a launch stool bolted to the concrete launch pad, and a transportable Integration Platform for elevating and placing the missile on the fixed launch stool. The launch stool is similar to the stool at LC-36 at WSMR. The LEAP Launch Vehicle will be protected from weather by a portable environmental shelter capable of withstanding 90 knot wind loads.

Mission profiles and dispersion areas are identified for each individual flight test. Dispersion areas for the original flights were identified in the LEAP EA. The dispersion areas are calculated

by ANSER. ANSER coordinates the mission requirements with the appropriate LEAP contractors and Space Data Division. The final requirements are documented in the SDIO/TNC Mission Requirements Document.

Coleman Research Corporation, a sub-contractor to ANSER's SDIO technical support, generates the preliminary and nominal 3-sigma dispersion trajectories with their six Degree-of-Freedom (6 DOF) trajectory and guidance models. Coleman coordinates mission event sequences, booster performance, guidance options, and range safety considerations with ANSER and Space Data Division to ensure consistency and accuracy of the flight profiles.

Space Data Division performs the detailed trajectory analysis necessary to satisfy range safety and payload specific requirements. This includes minimum/maximum analyses for booster performance, winds, and worse-case turns. ISI, another sub-contractor to ANSER, performs the validation of the Space Data Division final guidance algorithms and thus, the actual flight trajectories. This process is repeated, as necessary, to satisfy range safety, program specific, and environmental analyses. All of the models used in this process have been validated by performance data of past missions; and comparison of data between participating organizations.

1.2.3.1 LEAP-3

The LEAP-3 flight test at WSMR was evaluated in the LEAP EA. Since that time, two minor changes have been made to the flight test. First, LEAP-3 will incorporate a solid divert propelled LEAP projectile. The projectile will be fueled with Hydroxyl Terminated Polybutadiene (HTPB) and ammonium perchlorate as an oxidizer. These propellants are also components of the propellants used on the ASAS motor proposed for use on other LEAP flights. The original flight trajectory (Exhibit 1.8) has been changed, and is now identical to LEAP-1/-2 (Exhibit 1.9).

1.2.3.2 LEAP-X

As previously stated, LEAP-X is one of two new missions added to the LEAP program. The goal of the flight test is to evaluate and validate the performance of the ALAS and sensors in a flight environment, and to obtain data on ejected targets. The objectives of the test are to demonstrate LEAP technology and evaluate component capabilities and performance in realistic flight environments.

In addition to LEAP-5/-6/-7, LEAP-X will be launched from Meck Island. The flight profile and dispersion area are shown in Exhibit 1.10 and Exhibit 1.11. The Aries II Launch Vehicle will be used for the launch. This booster configuration is discussed in the LEAP EA. LEAP-X will be a single vehicle launch, and will carry a "Ultraseek" payload atop the Payload Module Bus, instead of the LEAP STPs and associated LEAP Axillary Equipment carried on LEAP-5/-6. The LEAP-X payload consists of a PMB, Ultraseek sensor package, ALAS, a Post Boost Vehicle (PBV) and Reentry Vehicle (RV) Decoy ejectable target, and cameras.

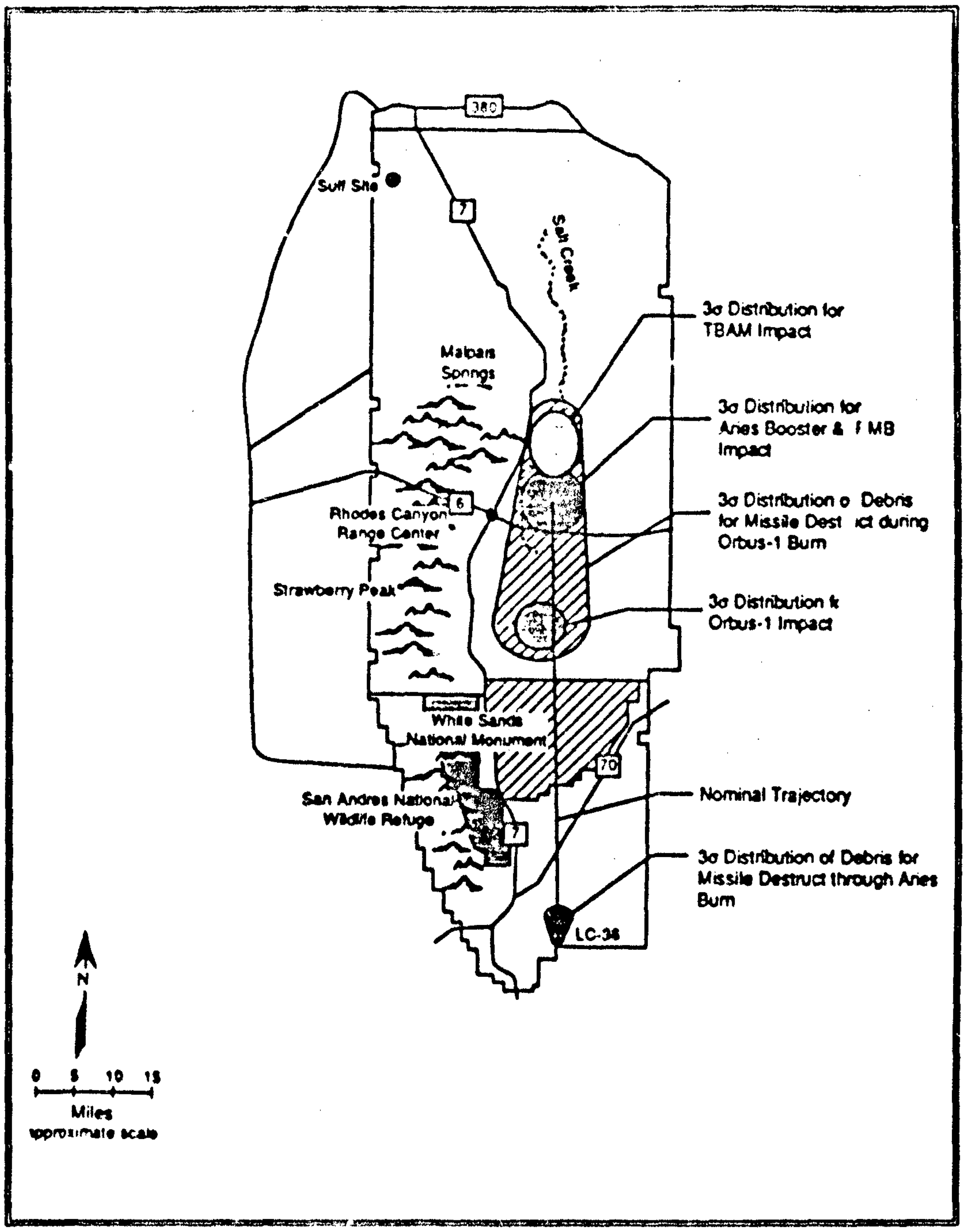

Exhibit 1.8: Old LEAP-3 Dispersion Area

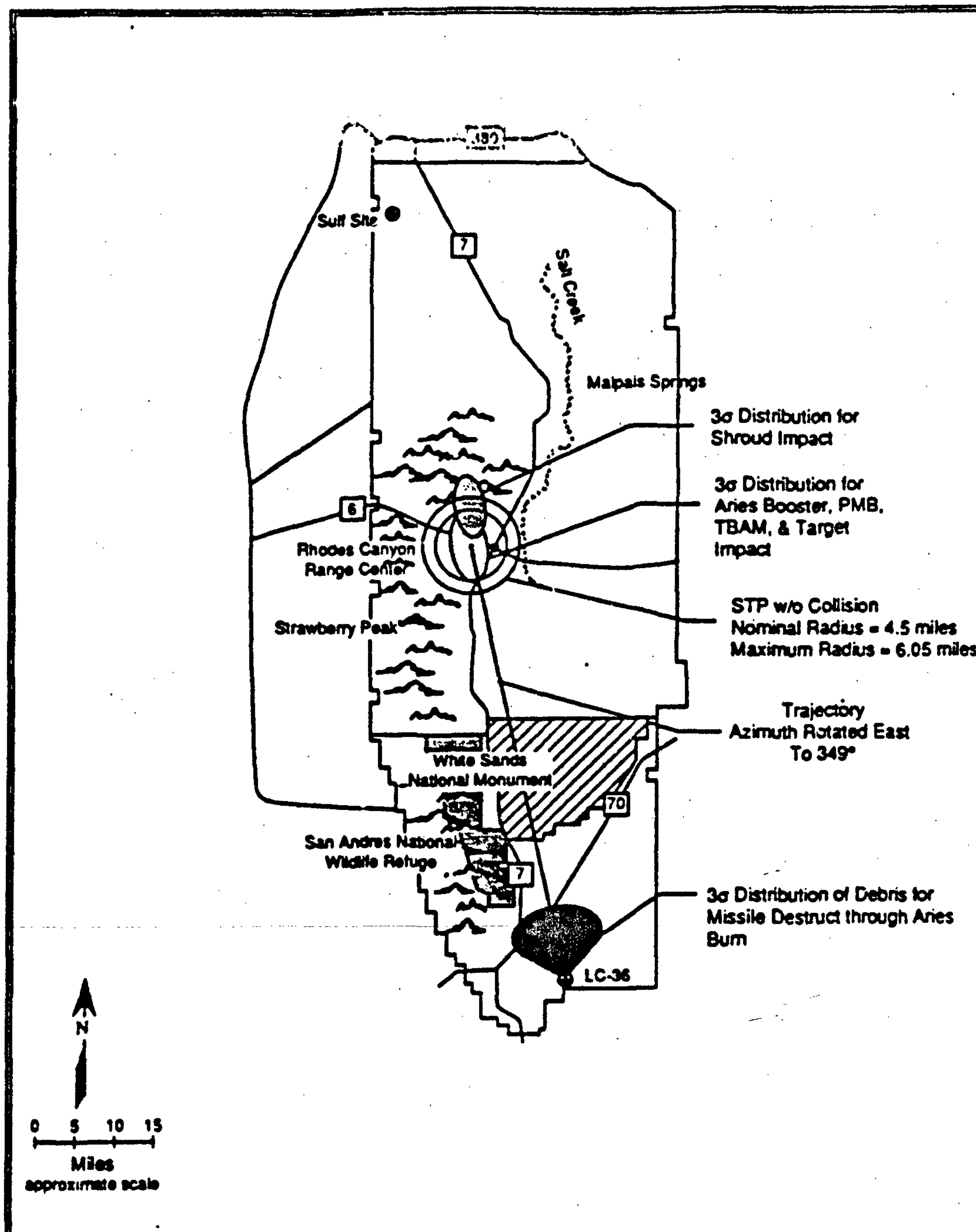

Exhibit 1.9: New LEAP-3 Dispersion Area

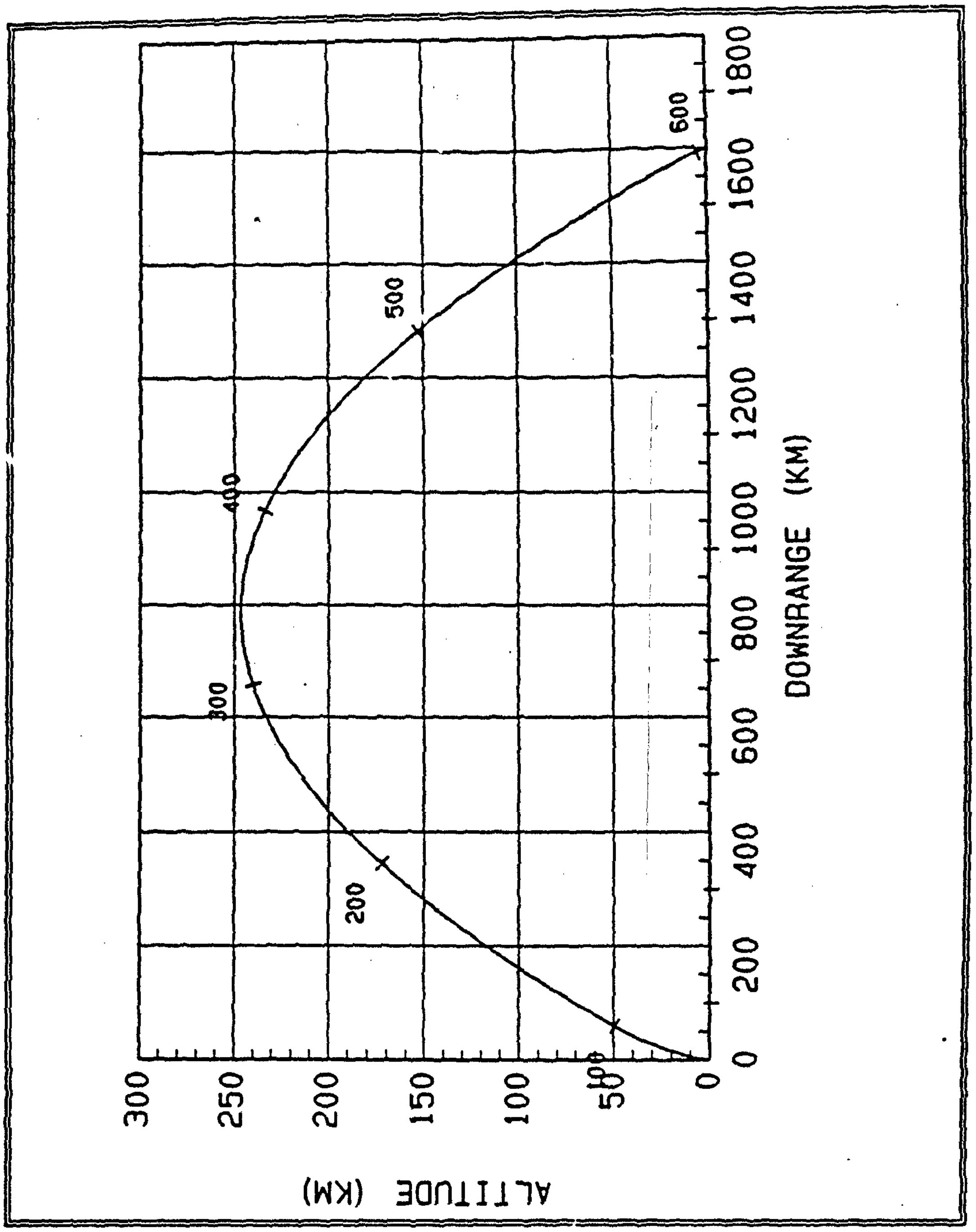

Exhibit 1.10: LEAP-X Mission Profile

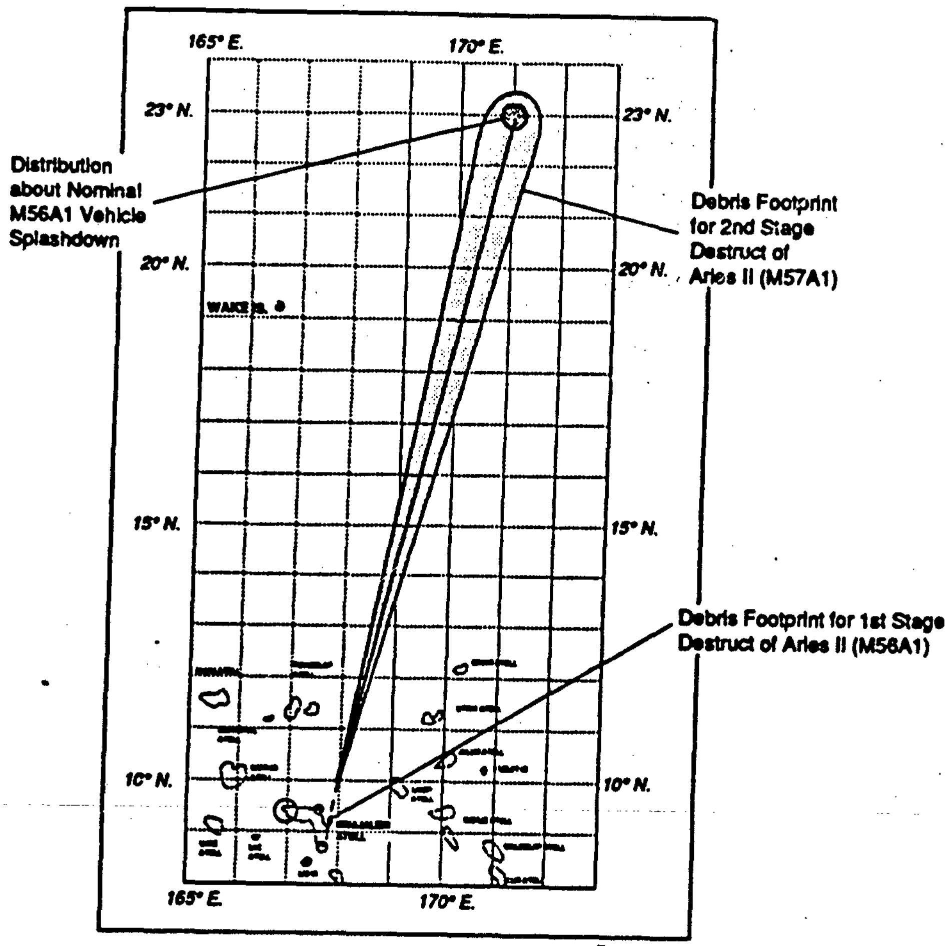

Exhibit 1.11: LEAP-X Dispersion Area

The Ultraseek is an advanced technology seeker which operates in the ultraviolet portion of the electromagnetic spectrum. The seeker is designed to acquire, track, and determine the aimpoint of targets. The Ultraseek measures 15" x 15" x 22", weighs twenty pounds, and consumes 35 Watts of power. The seeker is equipped with a custom high (2400V @ uAmp) and low (28V) voltage power supply. One of the primary advantages of the ultraviolet seeker is that the cooling of the detector and optics is not required, eliminating the need for cryogenic or high pressure components. The PBV Decoy is an inflatable PBV replica, measuring approximately 5" x 20" and weighing approximately ten pounds.

LEAP-X will carry the ALAS, which will be fired in an exoatmospheric environment. The ALAS will fire for approximately seven seconds, at altitudes between approximately 187 and 220 kilometers. The USNS Redstone will be available to track the LEAP-X vehicle from Meck Island, but will have no mission responsibilities. A HALO or ARGUS airborne observatory will observe the flight test. The aircraft will leave from Kwajalein Missile Range or Hickam Air Force Base, depending on aircraft availability. The aircraft will observe the mission under the direction of Kwajalein Missile Range and return to its base at the conclusion of the tests (Ref 17).

1.2.3.3 LEAP-5

The primary mission of the LEAP-5 flight test will remain as stated in the LEAP EA. Validating guidance dynamics and demonstrating seeker performance in a space environment are the primary goals. Objectives of the flight include a functional demonstration of LEAP technology by intercepting a post boost solid propellant target, and evaluating the LEAP projectile performance in realistic flight environments.

The flight profile remains largely the same, with a two stage Aries II LEAP Launch Vehicle launched from Meck Island and a target vehicle being launched from Wake Island. As previously stated, the launch at Meck Island will now occur from the HEDI area on the south portion of Launch Hill. The mission profile and dispersion area are illustrated in Exhibits 1.12 and 1.13.

The USNS Redstone will provide flight safety functions and data gathering (optical data, radar tracking data, and telemetry receiving and recording) for the LEAP target vehicle during the test. The Redstone will be positioned near Wake Island during the flight test. The Redstone is routinely used for this activity. White Sands Missile Range personnel were originally designated to perform these functions at Wake Island. This is a program change which precludes the use of telemetry sites at Wilkes Island (adjacent to Wake Island) as identified in the LEAP EA. A HALO or ARGUS airborne observatory will also be used during the flight.

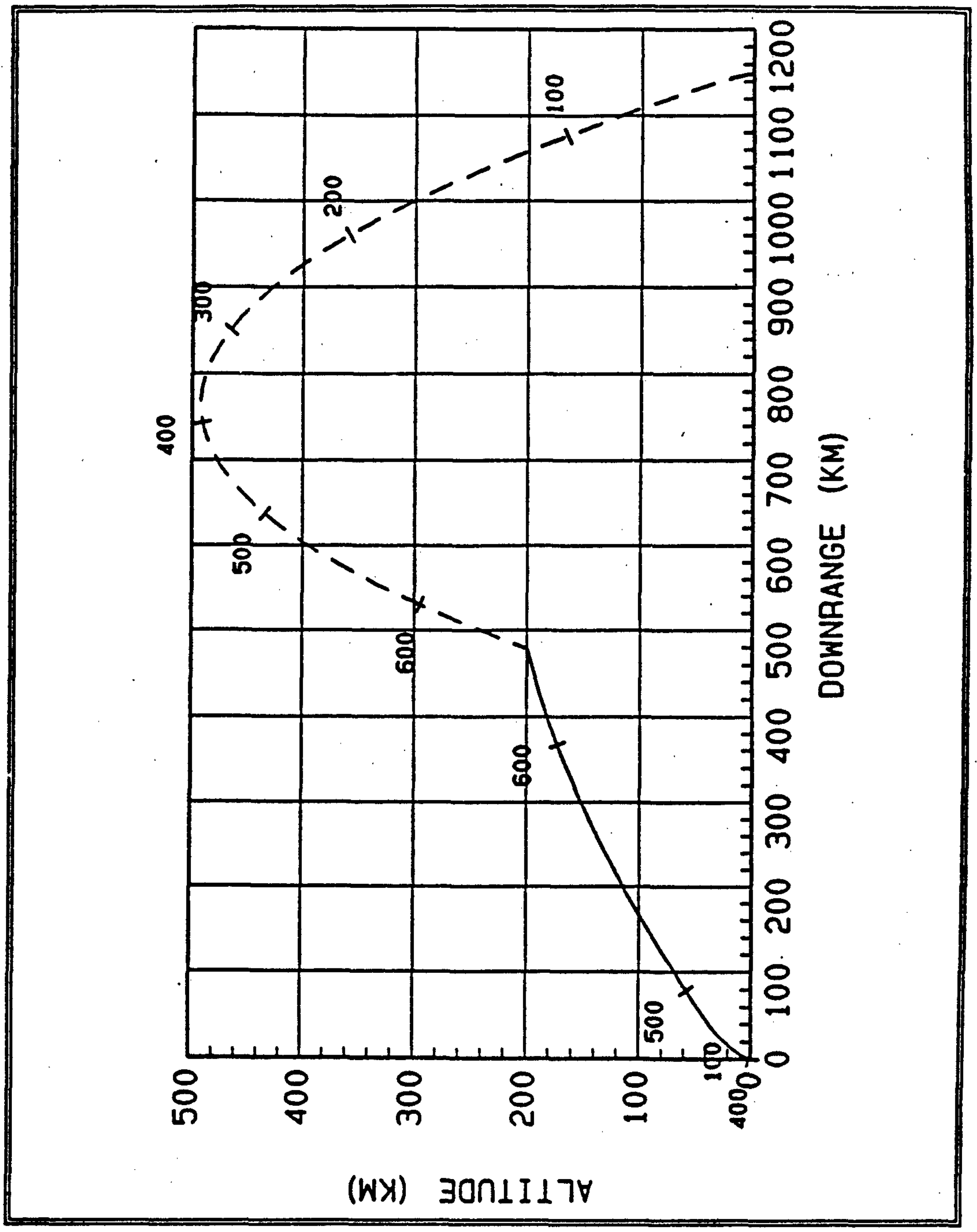

Exhibit 1.12: LEAP-5 Mission Profile

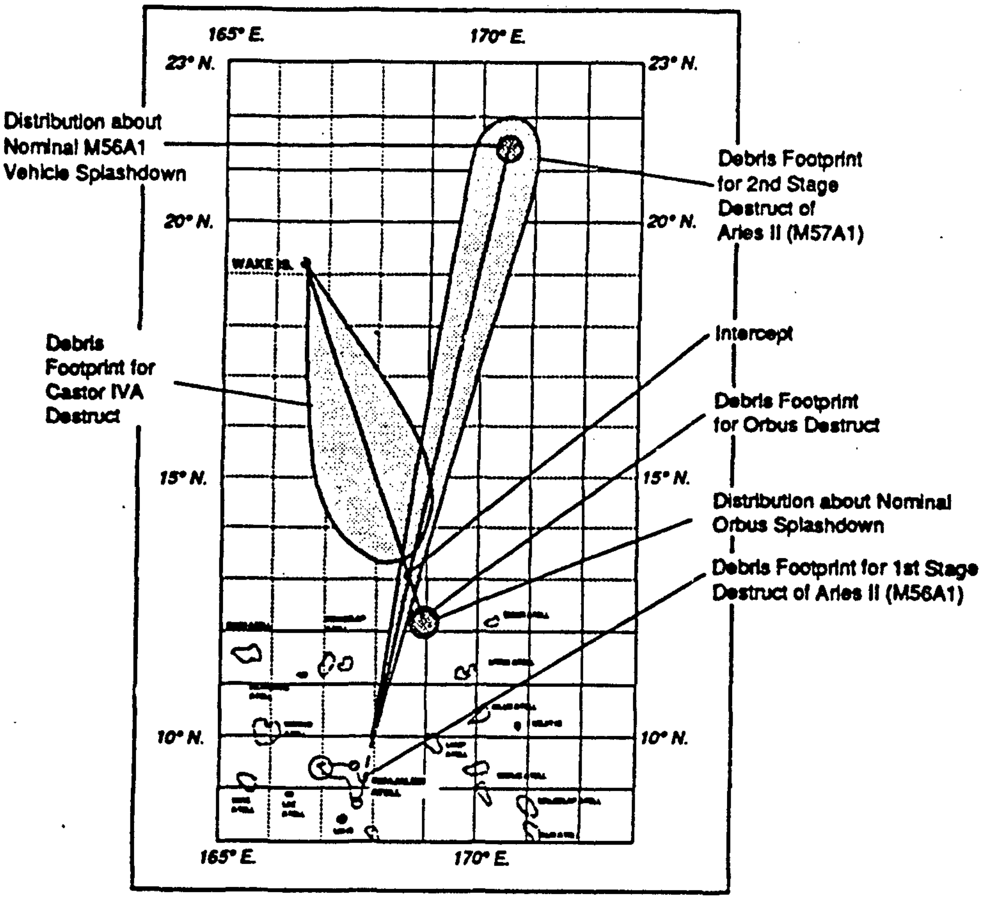

Exhibit 1.13: LEAP-5 Dispersion Area

1.2.3.4 LEAP-6

The LEAP-6 flight test was also evaluated in the LEAP EA. Similar to LEAP-5, the primary goal of the test is to validate guidance dynamics and demonstrate seeker performance in a space environment. Mission objectives of LEAP-6 are to provide a functional demonstration of LEAP technology by intercepting a post boost solid propellant target and to evaluate LEAP projectile capabilities and performance in realistic flight environments. The mission profile and dispersion area are illustrated in Exhibits 1.14 and 1.15

The USNS Redstone will support the flight test as described for the LEAP-5 flight. A HALO or ARGUS airborne observatory will also support the flight test. The LEAP-6 payload will include a Smart Interface Bus and the ALAS system. The ALAS will boost the vehicle to higher velocities, burning for approximately 35 seconds at altitudes between approximately 228 and 430 kilometers.

1.2.3.5 LEAP-7

The LEAP-7 flight test is another new test that has been added to the LEAP program. The goal of the LEAP-7 test is to demonstrate the ability of the LEAP projectile to acquire, track, and intercept a target. The objectives of the flight include demonstration of LEAP terminal guidance intercept capability, and to demonstrate the ASAS and ALAS axial performance capability (Ref 35). The ASAS and ALAS will be stacked on the PMB in the LEAP-7 configuration.

The LEAP-7 flight test will be a two-vehicle launch, including a LEAP Launch Vehicle launched from Meck Island and a target vehicle launched from Wake Island. As with LEAP-5/-6, the LEAP Target Vehicle will consist of a Castor IVA booster configuration. The mission profile and dispersion area for LEAP-7 are illustrated in Exhibit 1.16 and Exhibit 1.17.

The USNS Redstone will support the flight test as described for the LEAP-5 flight. A HALO or ARGUS airborne observatory will also support the flight test.

1.2.4 Post-Flight Activities

Post-flight activities will occur at USAKA and Wake Island, consisting of demobilizing LEAP equipment, decontaminating LEAP equipment, and properly disposing of hazardous wastes.

1.2.4.1 Facility De-Mobilization

Following the completion of the LEAP-7 flight test, LEAP specific equipment will be removed, and all facilities will be restored to their "pre-LEAP" condition. Equipment to be removed includes:

- PMB/STP alignment source on roof of MICB.

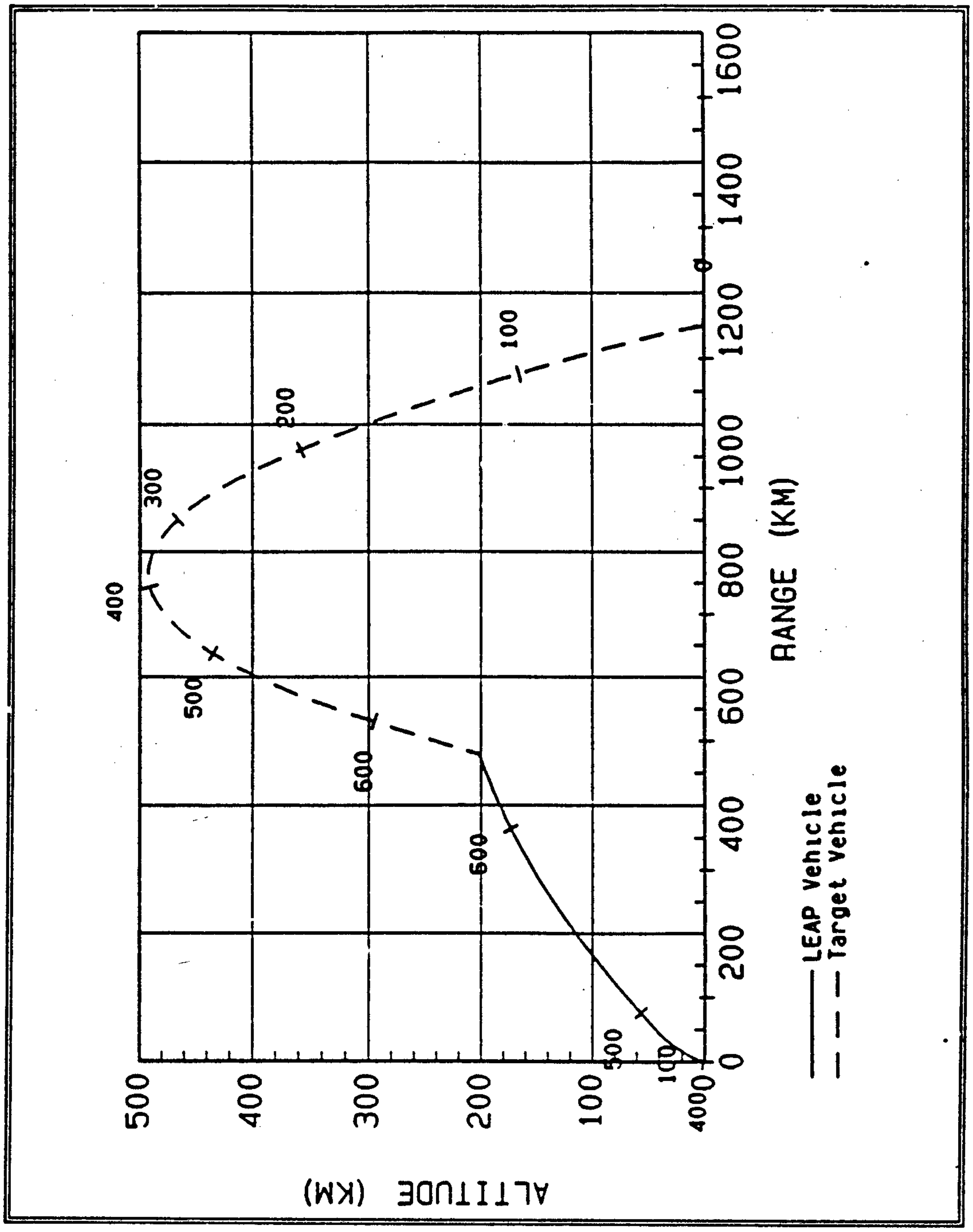

Exhibit 1.14: LEAP-6 Mission Profile

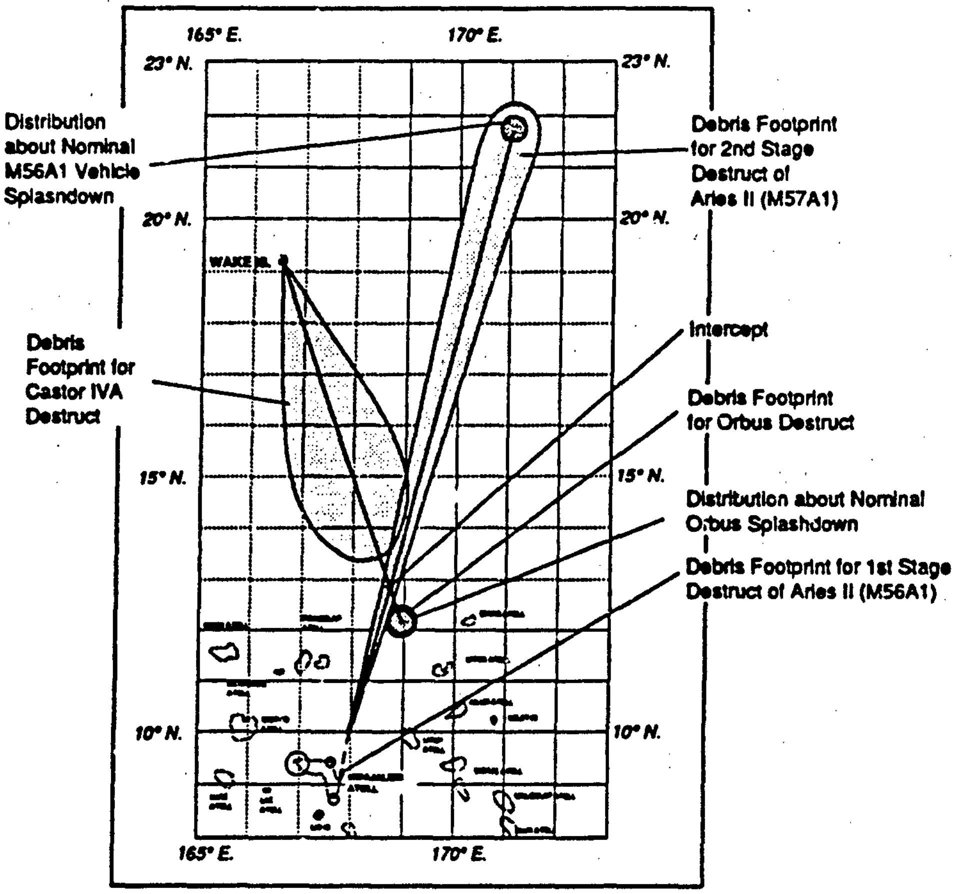

Exhibit 1.15: LEAP-6 Dispersion Area

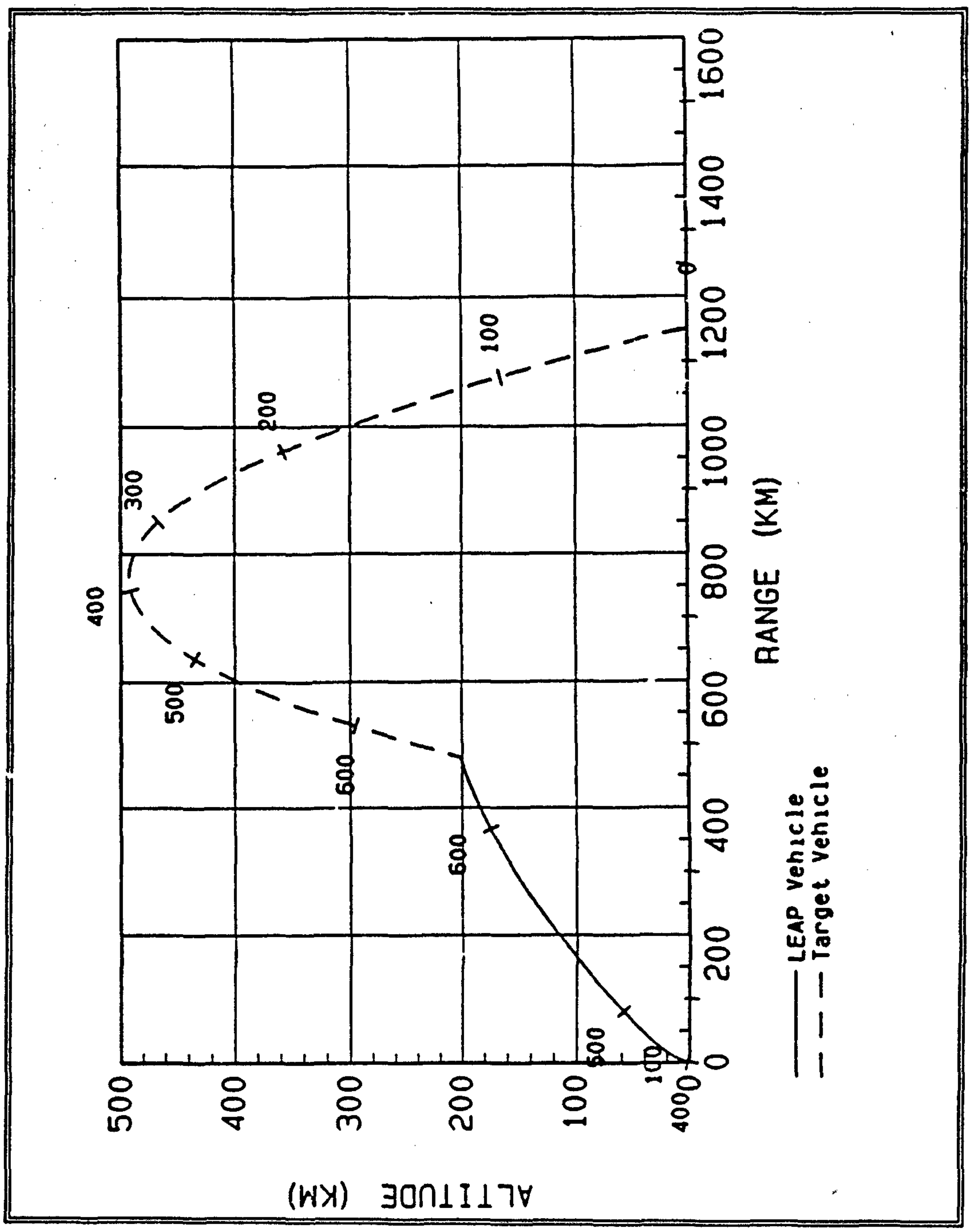

Exhibit 1.16: LEAP-7 Mission Profile

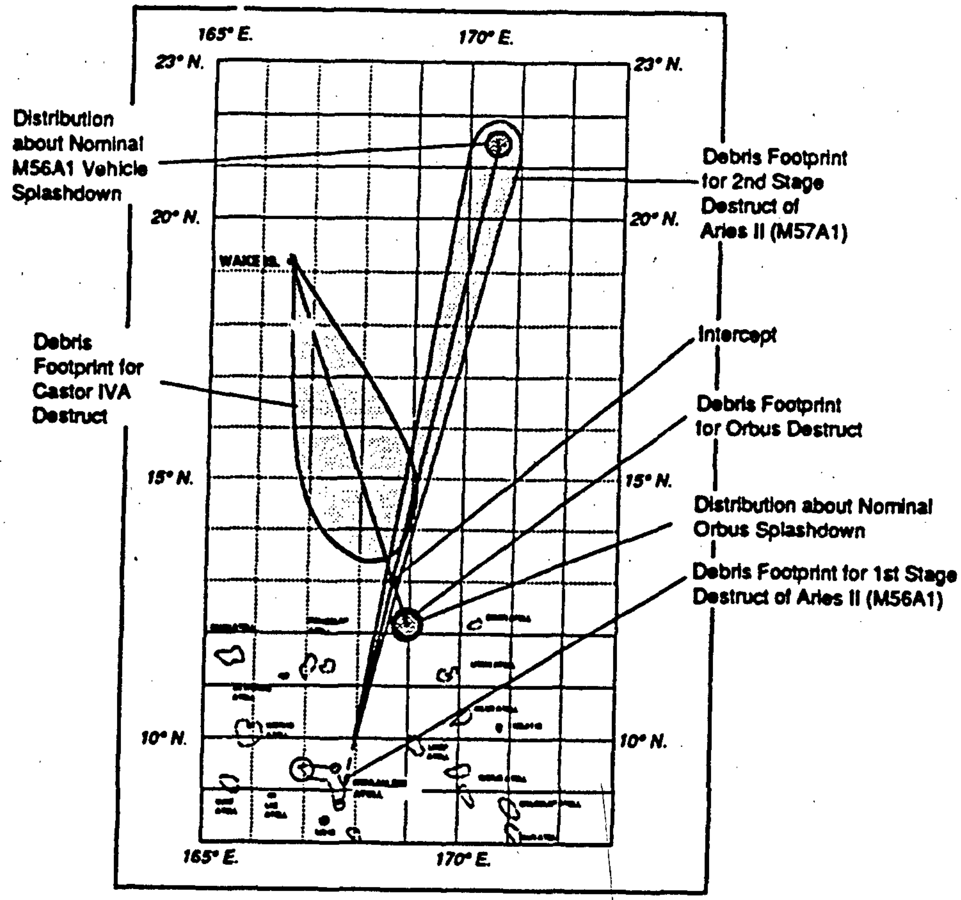

Exhibit 1.17: LEAP-7 Dispersion Area

- S-Band antenna on roof on MICB.
- Telemetry Reception equipment at Roi-Namur.
- LEAP Launch Stool from HEDI Launch Pad.
- Temporary fueling shelter in 5103.
- Environmental shelter tie-downs on HEDI Launch Pad.

1.2.4.2 Decontamination

Decontamination for the MMH, N_2O_4, and N_2H_4 fueling carts will be performed using the decontamination cart, and will occur in Building 5103. As identified in the LEAP EA, these systems are closed, preventing propellant release to the atmosphere. All gasses or liquids are removed by vacuuming. A water tank is an integral element in this closed system. Trace amounts of the propellants, after being purged through the system, are diluted in the water tank. This procedure, like the fueling procedure, is conducted in accordance with the Standard Safety Operating Procedure approved by the ground safety officer at USAKA prior to commencement of the procedures.

Decontamination of the ClF_5 fueling cart will be accomplished using the specifically designed and configured ClF_5 decontamination cart, which will be located off Lagoon Road on the west side of Meck Island. The decontamination cart is a carbon-based disposal system referred to as the charcoal burner. The system was designed by Aerojet and is presently used at their Sacramento, California facility. The carbon disposal material becomes an inert material. The material is not hazardous.

1.2.4.3 Hazardous Waste Disposal

As identified in the LEAP EA, Phillips Laboratory will be responsible for the removal of any unused or residual propellants. Phillips Laboratory with assistance from Aerojet, is also responsible for handling ClF_5.

As previously identified, decontamination of the hydrazine and nitrogen tetroxide loading carts culminates with trace amounts of the material being diluted with water in a closed tank. This propellant/water mixture will be returned to Phillips Laboratory at Edwards AFB and turned over to the proper contractors for proper treatment and disposal in accordance with RCRA regulations.

The ALAS loading system will be purged with helium following operations, which could potentially result in the release of trace quantities (the largest possible quantity is approximately 1/2 pound) of ClF_5 into the atmosphere. As previously stated, the carbon disposal material

becomes an inert material after decontamination procedures. The material will remain in the charcoal burner and return to Aerojet for further use. All these procedures are conducted in accordance with the USAKA EIS. Any substantial quantities of unused ClF_5 will be loaded by Aerojet into HOKE bottles and returned to CONUS, in reverse of the aforementioned transportation sequence.

1.2.5 Ground and Flight Safety

Safety procedures and launch and range control for the LEAP Test Program were identified in the LEAP EA. In addition, the LEAP EA includes a discussion of the reliability of boosters to be used in LEAP launches. A description of the explosives classification of materials used in the LEAP program is also presented in the LEAP EA. Explosives and safety information for the ALAS propulsion motor is presented in Appendix A. The procedures in the LEAP EA do not identify fuel handling procedures for ClF_5. These procedures are described in the following section.

1.2.5.1 Fuel Handling

ClF_5 is a clear, yellow-green, volatile liquid with a colorless gas. It has a sweet and irritating odor, and is suffocating when its concentration increases above 10 ppm. ClF_5 is extremely toxic, corrosive, and reacts vigorously with ice, water, and silicon-containing compounds (e.g., sand, glass, asbestos). It is incompatible with oil, grease, reducing agents organic compounds, plastics, rubbers, fuels and combustibles, and many metals and metal oxides (especially if powdered). Excessive exposure to ClF_5 vapors can be severely irritating and corrosive to skin, eyes, and respiratory tract. Exposure to high levels of vapor can be fatal. Liquid contact with the skin for as little as 0.2 seconds can produce severe burns. Permanent loss of vision can occur if liquid enters the eye.

ClF_5 is stable in special cylinders under normal storage and handling conditions. ClF_5 containers must be composed of compatible materials and be properly assembled and tested. Nickel, stainless steel, copper, Monel, aluminum and brass are all suitable materials (the HOKE bottles which will be used are composed of stainless steel). Since virtually all contaminants will react with the fluorinated oxidizers, detailed system cleanliness is essential. Aerojet cleans all ClF_5 propellant systems to a liquid oxygen compatible level. All systems are closed, then purged and cleaned with helium following all operations. The ALAS transportation, storage, and handling systems to be used for LEAP operations on Kwajalein Atoll have all been designed, fabricated, and assembled to meticulous safety specifications.

Because of these significant hazards, specific safety procedures have been developed for the handling and use of ClF_5. Workers must wear protective clothing and breathing apparatus, and receive special training and careful supervision to work with ClF_5. Personnel on the ALAS fueling team will receive initial and ongoing safety training classes on the propellant toxicity, exposure limits, first aid procedures, fire hazards, personnel protection measures, and safety

requirements. Personnel will always work in two man teams to insure continuous monitoring of individual safety. Personnel measures include the use of airline breathing units, self contained breathing apparatus (SCBA) units, Teflon impregnated suits, neoprene gloves, and acid goggles. Safety showers and eye baths must be located in the immediate vicinity of all handling procedures.

Procedures covering all fueling operations being performed by Phillips Laboratory or their contractor (Aerojet), which include the elements listed above, have been developed and are listed below.

- "ALAS LEAP X Flight Experiment: ClF_5 Loading System Receive and Inspect Procedure, APD-LEAP-X-210".
- "ALAS LEAP X Flight Experiment: ClF_5 Loading System Leak Check and Functional Checkout Procedure, APD-LEAP-X-220".
- "ALAS LEAP X Flight Experiment: ClF_5 Loading System Fueling Area and Control Room Setup Procedure, APD-LEAP-X-230".
- "ALAS LEAP X Flight Experiment: ALAS LEAP X FV Oxidizer and Nitrogen Loading Procedure (Haz Ops), APD-LEAP-X-240".
- "ALAS LEAP X Flight Experiment: ALAS LEAP X FV Oxidizer and Nitrogen Off-Loading Procedure (Haz Ops), APD-LEAP-X-250".
- "ALAS LEAP X Flight Experiment: ClF_5 Loading System Emergency Procedures for Equipment Failure (Haz Ops), APD-LEAP-X-260".

Atmospheric dispersion modeling for ClF_5 was conducted using the Air Force Toxic Dispersion Model (AFTOX) Version 4.0. AFTOX is an interactive Gaussian puff/plume model. It is an Air Force and EPA approved model designed for modeling "cold" or "evaporative" spills. Modeling was conducted based on the chemistry that 45 pounds of ClF_5 (the quantity to be used at KMR) will react with the atmosphere and moisture to form 37.4 pounds of Hydrogen Fluoride (HF) and 13.2 pounds of Chlorine (Cl). Modelling was also conducted for 76 pounds of hydrazine (9 gallons) which will also be shipped to KMR.

The model accounts for accident scenarios during the transportation and handling procedures for the propellants. The model identifies maximum exposure levels for an accident in order to establish safety corridors during operations. Meteorological conditions were selected based on actual normals and means taken from historical weather data obtained from the Kwajalein weather office.

The AFTOX model predicts the mean hazard distance. To be confident in the models predictions to a high degree, correction factors are applied to the mean hazard distances. The correction factor yields a 90 percent confidence in hazard corridor predictions. These hazard corridors are coordinated with USAKA safety personnel.

The applicable LEAP Safety Standard Operating Procedures (SSOP) for liquid fuels are submitted to the USAKA ground safety office for their review and approval. These procedures are described in the LEAP EA.

1.3 Alternatives

Analyses were conducted to evaluate potential alternatives for axial propulsion motors and oxidizers used in these motors. These analyses are presented in the following sections. The no-action alternative to the proposed program modifications is also presented.

1.3.1 Alternative PMB Propulsion Motors

A large number of liquid rocket motors exist which could conceivably perform as the interceptor propulsion system. Critical elements in the space-based segment of the SDI program are lightweight, compact kinetic energy weapons (interceptors), and highly maneuverable and accurate sensor systems. These interceptors and sensors require advanced chemical propulsion systems to achieve the required axial boost (down range) and divert (cross range) velocity increments. System trade studies revealed that lightweight components could only be achieved with breakthrough design and fabrication techniques. The ALAS was chosen as the LEAP PMB propulsion motor because of the need for actual flight test data and lightweight components.

The most important components in achieving lightweight design are the engine, tank, and pressurization system (ref. 10). In a design and testing of a space based liquid booster study (ref. 10), propellant tank materials and configurations were analyzed: aluminum tanks, which are the heaviest; conventional high performance tanks, from which no clear choice emerges; and unconventional composite tanks which are shape optimized (ref. 10). From this study, the development of a nonload sharing carbon fiber overwrapped tank advanced liquid rocket technology by decreasing tank weight (ref. 10).

The important consideration for selecting the Advanced Liquid Axial Stage (ALAS) was that the ALAS uses high tensile strength carbon material wherever possible to reduce weight (ref. 12). The carbon materials are compatible with the propellant ClF_5/N_2H_4 (ref. 12). In addition, carbon or ceramic chambers were favored materials because the principal combustion products of ClF_5/N_2H_4 are HF and HCl (ref. 10). Therefore, the weight in the ALAS is minimized by the selection of a very high impulse, high density propellant combination; by miniaturizing control components; and, by using pressurization schemes that add component weight but decrease system weight (ref. 12). In an ALAS study, ClF_5/N_2H_4 propellants were ideal propellants for the

ALAS because the propellant is earth storable; resulted in the lightest missile (of the earth storable propellant candidates); is hypergolic; and resulted in high combustion efficiency (ref. 12).

1.3.2 Alternative ALAS Oxidizer

Chlorine pentafluoride (ClF_5) has been selected as the oxidizer for ALAS in combination with hydrazine (N_2H_4) fuel. This propellant combination leads to lightweight design with increased performance rate in the ALAS. In combination with PMB propulsion motor considerations, the ClF_5/N_2H_4 propellant was chosen for minimal erosion of materials and lightweight booster capabilities.

In determining a suitable propellant, several studies were analyzed to determine possible propellant combinations for space based liquid boosters. In a propellant selection consideration study (ref. 11), approximately 50 propellant combinations were considered and studied. The primary propellant selection criteria was minimizing booster weight by maximizing performance specific impulse. Initially, 11 oxidizers, 12 fuels, and seven additives were selected, which lead to 924 possible propellant combinations. Through initial screening processes, propellant combinations were reduced to 57. These combinations included earth storable propellants to deep cryogens, with and without metal additives. From this study, the number of propellant combinations were reduced to ten (Exhibit 1.18). The study concluded that minimum weight boosters could be achieved with the space storable propellant combination using Oxygen difluoride (oxidizer) / Diborane (fuel) (OF_2/B_2H_6), Nitrogen Tetroxide / Monomethylhydrazine (N_2O_4/MMH), or Chlorine Pentafluoride / Hydrazine (ClF_5/N_2H_4) (ref. 11).

According to a study for designing and testing a space based liquid booster (ref. 10), additional system considerations should have been considered in determining propellant selection for space based liquid boosters. These considerations included hypergolicity, space storablity, adverse combustion effects, launch restraints, and toxicity. This study concluded, after examining approximately 50 different propellant combinations, that a compromise propellant to OF_2/B_2H_6 was Chlorine Pentafluoride / Hydrazine (ClF_5/N_2H_4). For earth storable propellants, the ClF_5/N_2H_4 propellant combination resulted in the lightest booster. Significant weight efficiencies were also achieved with semi-cryogenic propellants such as OF_2/B_2H_6 and CF_2/light hydrocarbons (ref. 10). The study, however, found that the propellant, OF_2/B_2H_6 using different lined chambers and injectors, experienced boron and boron oxide deposition. This propellant increased plugging of fuel orifices (openings) during tests, which lead to performance degrades and mixture ratio increases, preventing efficient fuel mixtures (ref. 10). Moreover, localized erosion occurred near the plugged elements (quadlet and triplet injector faces) (ref. 10). According to another study (ref. 11), substantial chamber erosion occurred when operating with B_2H_6 propellants and carbon chamber materials.

Oxidizer / Fuel	Compound
Lithium Difluoride / Diborane	LF_2/B_2H_6
Oxygen Difluoride / Diborane	OF_2/B_2H_6
Lithium Difluoride / Hydrazine + Beryllium Hydride	LF_2/N_2H_4 + 26%BEH_2
Oxygen Difluoride / Diborane - Aluminum	OF_2/B_2H_6 - 19% Al
Oxygen Difluoride / Propane	OF_2/C_3H_8
Oxygen Difluoride / Propane + Aluminum	OF_2/C_3H_8 + 15%Al
Fluoridated Oxidizers / Methane	$FLOX/CH_4$
Nitrogen Tetrafluoride /	N_2F_4/B_5H_9
Chlorine Pentafluoride / Hydrazine	ClF_5/N_2H_4
Nitrogen Tetroxide / Monomethylhydrazine	N_2O_4/MMH
Source: Propellant Selection Consideration for Space Based Liquid Booster (ref. 11)	

Exhibit 1.18: Oxidizer Alternatives

1.3.3 No Action Alternative

Implementing the no-action alternative would result in conducting the LEAP flight test experiments in accordance with the July 1991 LEAP EA and FONSI. The changes proposed to the LEAP flight test experiments would not be implemented. In addition, the two additional launches, LEAP-X and LEAP-7, would not occur. These changes are deemed necessary by SDIO, however, to fulfill the LEAP flight test objectives. Without the anticipated data resulting from the LEAP flight tests as proposed, the LEAP program objectives will not be accomplished, and SDIO will not be able to fulfill their mission requirements for an effective Strategic Defensive System (refer to the LEAP EA/FONSI for additional discussion of the no-action alternative).

Existing Conditions 2.0

2.0 Existing Conditions

The existing conditions encompass the physical attributes of locations that potentially are affected by the proposed action and no action alternative. Existing conditions include the physical setting, water resources, air quality, noise, and safety considerations, etc. at component assembly/test locations and pre-flight/flight test locations. As previously indicated, the LEAP EA is incorporated by reference; therefore, this section presents a brief summary of the conditions as originally described in that document. Much of the existing conditions description in the LEAP EA was derived from the USAKA EIS completed in 1989.

2.1 Component Assembly / Test Activity Locations

Information regarding the technical operations of component assembly/ground test participants in the LEAP test program was obtained using questionnaires distributed to contractor facilities. Contractor activities not addressed in the LEAP EA include Aerojet, Inc. and Thiokol, Inc. The goal of the questionnaires was to identify current facility activities, the existing environment, activities pertaining to the LEAP program, and the status of environmental compliance.

The questionnaire required specific information from contractors on environmental and safety documentation (including permits), Resource Conservation and Recovery Act (RCRA)/Superfund status, and potential to impact the following environmental resources: physical setting and man-made environment, water resources, geology and soils, air quality, noise, biological resources, threatened and endangered species, cultural resources, infrastructure, hazardous materials and wastes, and public health and safety.

2.1.1 Aerojet Propulsion Division

Aerojet is fabricating and testing the ALAS axial propulsion motor at its facilities in Sacramento, California. The facility, dedicated to the manufacture and testing of liquid rocket engines and components, is located in a rural area outside of Sacramento on 13,000 acres. Activities similar to those planned to support the LEAP program are routinely performed at the facility. No new structures or additional personnel will be needed to support LEAP program activities. The LEAP activities are planned to occur in the J-Zone area of the facility (ref 39).

The Aerojet facility has not been identified as habitat for threatened or endangered species. No wetlands, archaeological remains, historical sites, prime agricultural land, coastal zones, floodplains, aquifers, or scenic rivers are present at the facility. A recent audit by the California Department of Toxic Substance Control found the facility to be in compliance with no discrepancies. Aerojet maintains a current RCRA permit for the facility. No new or special safety permits are needed for LEAP related activities. The propellants used for the ALAS testing

are categorized as hazardous. As identified in Section 1, Aerojet has used these propellants previously without incident, in accordance with relevant regulations (ref 39).

2.1.2 Thiokol Corporation

Thiokol Corporation, Elkton Division, located in Elkton, Maryland, will conduct motor design and development testing of the ASAS. The scope of work is typical of new product development and qualifications using proven technology (at near state-of-the-art levels). The ASAS Development program, initiated in March 1988, received redirection in January 1992 to support LEAP flight experiments until 1994 (ref 40).

The facility employs 504 people and consists of 230 buildings on approximately 500 acres. The facility is located within a rural area between industrial, commercial, and agricultural land uses, and has been located at this site since 1948. ASAS activities will utilize approximately 30,000 square feet of a total 370,000 square feet in the following buildings: Case Winding (C-52), Lining (A-66), Casting (C-26), Insulation (G-20), Machine Shop (G-16), and Altitude Testing (C-20A). Test activities will require 10 additional employees; however, no new structures or modifications/expansions to existing facilities will be required to accommodate ASAS testing. In addition, the facility will not require decommissioning (ref 40).

The facility has not been cited by the Environmental Protection Agency (EPA) for regulatory violations and is not on the National Priorities List (NPL). Similar activities have been conducted at Thiokol in the past: for example, the Space Based Interceptor program utilizing beryllium propellants occurred at the Thiokol facility. The entire facility has existing environmental permits on file which regulate activities (RCRA Part B Permit, National Pollutant Discharge Elimination System (NPDES) Water Discharge Permit, and Maryland air emission permit); in addition, environmental documentation has been performed as part of these permitting processes. No additional Federal/state/local government permits will be required (ref 40).

Ammonium perchlorate, powdered aluminum, and solvents will be used and generated at the facility; however, a RCRA permit is maintained and no new or revised permits will be required for this activity. Trucks (commercial/temperature controlled) will be used to make shipments to and from Thiokol; however, these activities are regulated by DOT. Trucking activities will require classification and letter of competent authority. In addition, an existing safety plan (Safety directive system, Emergency and Disaster Plan, July 1991) regulates the overall facility; no product specific plans will be required for LEAP 7. A Field Handling Manual, however, may be required (ref 40).

The facility is not considered habitat for threatened or endangered species. Additionally, no archaeological or historic sites, prime agricultural land, wilderness areas, or wild and scenic rivers are located on the site. Wetlands, aquifers, and floodplains are located on the 500 acre site; however, these resources have not been identified as areas of concern (ref 40).

2.2 Pre-Flight and Flight Test Activity Locations

Pre-flight and flight tests are proposed at the following locations: White Sands Missile Range, U.S. Army Kwajalein Atoll, and Wake Island.

2.2.1 White Sands Missile Range (WSMR)

As identified in Section 1.0, the LEAP-3 launch has been modified with a new azimuth/trajectory, resulting in a re-evaluation of potential environmental impacts from this launch. The new flight corridor and impact area for the LEAP-3 launch will be identical to the corridor and impact area identified for LEAP-1 and -2 in the LEAP EA. As a result, all areas that could potentially be affected by the modified LEAP-3 launch have already been discussed in the LEAP EA and will not be affected by this change. Consequently, the discussions of existing conditions at WSMR will not be repeated in this document.

2.2.2 U.S. Army Kwajalein Atoll (USAKA)

This section summarizes the affected environment section of the LEAP EA and includes changes in procedures and the affected environment since publication of the USAKA EIS. In particular this section focuses on the affected environment at Meck, Roi-Namur, and Kwajalein Islands.

2.2.2.1 Physical Setting and Land Use

Kwajalein Atoll, part of the Republic of the Marshall Islands, is a coral reef containing approximately 100 islands surrounding the largest lagoon in the world. The Atoll is located in the North Pacific Ocean 4,278 miles southwest of Vandenberg AFB, and 2,136 miles southwest of Honolulu.

The U.S government leases 11 of these islands from the Marshallese government: Kwajalein, Roi-Namur, Meck, Ennylabegan, Legan, Illeginni, Gagan, Gellinam, Omelek, Eniwetak and Ennugarret. These islands, known as USAKA, total 3,584 acres (5.6 square miles) and are used by the Department of Defense (DoD) as a Major Range Testing Facility Base (MRTFB). The facility is used to conduct launches allowed under the 1972 Anti-Ballistic Missile (ABM) Treaty. Of the 11 USAKA islands, Kwajalein, Meck, and Roi-Namur are the most developed. Kwajalein Island is the headquarters for missile range operations; Meck and Roi-Namur are used for periodic missile launches, and have facilities to store and assemble missile components (ref 38).

2.2.2.2 Geology and Water Resources

A. Island Geology

All islands of the Atoll are nearly flat, with few natural points exceeding 15 feet above mean sea level (MSL). Reef rock is formed entirely from the remains of marine organisms such as reef corals, coralline algae, foramnifera, and others. Only the upper thin layer of the reef, which is under water, is alive and growing. The organisms that form/inhabit the reefs are vulnerable to sedimentation, burial, and changes in circulation caused by man's development activities. Soils are coarse, alkaline, and have low organic matter content.

B. Surface Water

Rainfall is the primary source of fresh water for USAKA. The principal rainfall season is from May through November with an annual average rainfall of approximately 100 inches. Rainfall is collected directly in catchments.

C. Groundwater

Groundwater is pumped from lenses of freshwater that float on top of deeper marine waters in the island subsurface rock strata. Due to fluctuations in rainfall, groundwater is essential to the supply of potable water at USAKA. Groundwater is a major source of potable water on Kwajalein and Roi-Namur islands. Chloride levels in the groundwater are monitored to ensure they do not exceed the potable limit of 250 mg/l. Samples of water on Kwajalein Island were analyzed as part of the U.S. Army Drinking Water Surveillance Program and tested for maximum contaminant levels and secondary maximum contaminant levels as established under the National Primary and Secondary Drinking Water Regulations. The samples were below the maximum and secondary maximum contaminant levels.

D. Marine Resources

Marine water quality around the USAKA islands has generally been satisfactory, except in the immediate vicinity of a few point and non-point sources involving sewage, suspended sediment, and sandblasting material. USAKA has two NPDES permits for Kwajalein, Meck, and Roi-Namur islands for sewage and industrial discharges. Waters off Roi-Namur are generally excellent, with specific exceptions (e.g., sewage discharge). Water quality remains satisfactory due to the generally good mixing and dilution from tidal, tradewind, and wave-generated offshore currents.

2.2.2.3 Air Quality

The climate at USAKA is classified as tropical marine, characterized by relatively high annual rainfall and warm to hot humid weather. Annual average rainfall is 104 inches. Average

monthly temperature ranges from 80 to 85 degrees F. The lowest temperatures during the year are approximately 70 degrees F, and the highest temperatures are approximately 90 degrees F.

Air quality at USAKA is generally characterized as good because of the low number of air pollution sources and wind dispersion patterns. Power plants, fuel storage tanks, solid waste incinerators, waste oil disposal, and transportation are the primary air pollution sources at USAKA. Pollutant concentrations throughout most of the islands are within U.S. ambient air quality standards. Some exceedances of carbon monoxide (CO), particulate matter (PM) 10, and nitrogen oxides (NO_x) occur west of both Power Plant 1 and the solid waste burning pit of Kwajalein Island. The exceedances are primarily the result of burning of solid waste in a forced air incinerator and emissions from the power plants. New air quality controls are being implemented. A new solid waste incinerator with air pollution controls is scheduled for completion in March 1994.

2.2.2.4 Noise

Primary noise sources at Kwajalein Island include aircraft operations. Other sources of noise include the power plant, sand blasting, air conditioners, and diesel engines generators. Primary noise generating sources at Meck Island are diesel-engine generators; building air conditioning units; and heavy equipment such as forklifts, trucks, etc. Secondary noise sources include helicopters and marine craft. Primary noise sources at Roi-Namur include aircraft operations and missile launches. Other sources include the power plant and air conditioning units.

Noise limits are outlined in Chapter 7 of Army Regulation 200-1, entitled "Environmental Noise Abatement Program". Specific limits under the program are illustrated in the USAKA EIS. Ambient levels were not measured as part of the USAKA EIS. Standard Safety Operating Procedures are implemented for all programs which occur at KMR.

2.2.2.5 Biological Resources

There are 315 vascular floral species at USAKA, 61 percent of which are cultivated plants. There are 51 wildlife species known to inhabit the USAKA islands, including many species of migratory and nesting birds. Nesting birds nest on the ground or in vegetation, and tend to be located on isolated, uninhabited islands. These nesting species have been reduced in numbers due to the loss of nesting habitat from past construction activities at USAKA, however, no specific data exists regarding their actual numbers.

Marine habitats at the Kwajalein Atoll include ocean reefs, lagoon reefs, lagoon floor and sand flats, harbors, piers, quarries, and sea grass beds. Several reef species are present in the reefs surrounding the islands. These species are important due to their recreation and subsistence value to the indigenous population and maintenance of the physical foundation of the reefs.

2.2.2.6 Threatened and Endangered Species

There are no known threatened or endangered terrestrial plant or animal species on the Kwajalein Islands. Threatened or endangered marine species that may be found in the surrounding waters include the green sea turtle (*Chelonia mydas* - U.S. listed threatened species), the hawksbill turtle (*Eretmochelys imbricata* - U.S. listed endangered species), the giant clam (*Tridacna gigas* - proposed for listing by the Republic of the Marshall Islands and the U.S. National Marine Fisheries Service), and a rare seagrass (*Halophilla minor*) on Kwajalein and Roi-Namur islands.

All of these species are vulnerable to actions that directly disturb habitat, or change water quality. Changes in water quality may include runoff or discharges from adjacent lands, which contribute to increases in turbidity and pollutant loadings. Coconut crabs, recommended for special protection within the Republic of Marshall Islands, have been observed on Roi-Namur. Turtle nesting has been alleged, but not documented on the USAKA islands (LEAP 1991)

Sessile species, such as the giant clam and seagrass, are particularly vulnerable to changes in water quality since they are stationary. In addition, adverse changes in water quality would also affect the sea turtles, either directly in exposing them to pollutants, or indirectly by damaging their food sources.

2.2.2.7 Cultural Resources

Kwajalein Atoll contains a wide variety of both prehistoric and historic resources. Prehistoric resources date from approximately 1,000 BC until European contact in the mid-sixteenth century. Historic resources may date from the sixteenth through twentieth centuries.

Kwajalein is and has subsurface prehistoric and historic remains correlating with the original island surface. Roi-Namur has been highly disturbed, and very little of the original island surface is intact. Kwajalein and Roi-Namur Islands have been included on the National Register of Historic Places since 1984 for their association with important World War II engagements in 1944. These properties are known as the Kwajalein Island Battlefield National Monument and the Roi-Namur Battlefield National Monument. The greatest density of architectural resources from the World War II period are located on Roi-Namur Island. Potential underwater cultural resources associated with warships sunk during World War II and airplanes either shot down or ditched in the surrounding waters have not been investigated for inclusion on the National Register.

2.2.2.8 Infrastructure

Operations at USAKA include provision of potable water, waste water treatment, solid waste removal, medical services, education, and housing to the personnel stationed at the base.

The waste water treatment plant on Kwajalein Island is near its design hydraulic capacity. The plant handles the load without performance problems. Waste water on Roi-Namur is handled through four tank/leach fields and one outfall to the ocean. A new sewage treatment system is scheduled for construction on Roi-Namur in 1994. Waste water on Meck Island is handled through a septic tank and leach field system.

Kwajalein and Roi-Namur Islands have established solid waste collection and separation operations. Combustible solid waste is burned in open-air pits. Most noncombustible waste is buried in landfills or open dumps. Construction debris is removed from remote sites to the Kwajalein or Roi-Namur landfills. Operation solid wastes are shipped from Meck Island to a Kwajalein Island landfill.

Housing facilities are located solely on Kwajalein and Roi-Namur Island. Transient housing at USAKA includes the use of open barracks. In addition, there are capacity problems in the USAKA school system, primarily in grades K through 6. There are no infant child care facilities at USAKA.

2.2.2.9 Hazardous Materials and Wastes

Activities related to the use and storage of hazardous materials and wastes at USAKA are concentrated on Kwajalein, Roi-Namur, and Meck Islands. Hazardous materials include rocket propellants, explosives, paint products, explosives, and pesticides. Hazardous wastes include asbestos, solvents, paint products, and PCBs. Hazardous materials and wastes are removed from USAKA for disposal, including recycling. Hazardous waste at USAKA is regulated under RCRA guidelines per Section 161 of the Compact of Free Association (48 USC 1681). A new Hazardous Materials Storage Facility is planned for construction in 1993. Handling of hazardous waste is regulated by 29 CFR 1910 (OSHA).

2.2.2.10 Public Health and Safety

Safety measures at USAKA must address handling and storage of explosives, fuels, rocket propellants, construction operations, missile assembly and storage, launch activities, and toxic and hazardous waste handling.

Programs involve compliance with OSHA regulations and USAKA Regulation 385-75, which governs treatment of explosives. These regulations are implemented by the USAKA Safety Office. Launch facility operations are subject to review by the DoD Explosives Safety Board.

2.2.3 Wake Island

As identified in Section 1, the only proposed modification to the LEAP program at Wake Island is the addition of one target launch to support the LEAP-7 test flight. As with the program

changes at WSMR, the modifications at Wake Island will not change the affected environment descriptions identified in the LEAP EA. Therefore, the existing conditions at Wake Island have not been addressed in this document.

Consequences 3.0

3.0 Consequences

The purpose of this section is to identify potentially significant impacts, if any, resulting from implementing the proposed changes to the LEAP program. The only modification which is a significant departure from the previous analyses is the addition of the ALAS and ClF_5 to the program. This analysis is driven by that change. All other program elements are addressed in the LEAP EA. The consequences of implementing the proposed action are described in Section 3.1 and the consequences of implementing the no action alternative are described in Section 3.3.

The methodology employed to identify potentially significant impacts involved three phases. First, a determination was made, after implementation of the engineering/environmental practices and safety measures described in Section 1.0, whether the proposed action would result in any impacts to the environmental resources described in Section 2.0.

In the second phase, it was determined if these impacts were potentially significant, as defined in 40 CFR Part 1508.27. The emphasis is to determine both the context in which the action will occur and the intensity of the action. The action was reviewed in the context of various laws and regulations to determine if impacts exceeded defined threshold levels (e.g., NAAQS, violation of an Army noise regulation, etc.). Potential impacts resulting from implementing the proposed action that did not meet these criteria for potentially significant impacts were considered to have no significant impacts on the evaluated resources.

Finally, for any impacts from the proposed action that were potentially significant, it was determined whether mitigation measures could be implemented to reduce the impacts to less than significant levels. An analysis of the cumulative impacts resulting from the proposed action are reviewed in Section 3.4.

3.1 Proposed Action - Component Assembly/Test Locations

The environmental questionnaire distributed to the engineering contractor facilities as described in Section 2.1, was used to evaluate the compatibility of LEAP test program technologies and required activities with the environment at those facilities and current facility activities.

3.1.1 Aerojet

LEAP program activities at Aerojet will occur in existing facilities and will not require modification. The proposed LEAP activities will occur within the context of routine operations at the facility, and required permits regulating these activities are in effect. As noted in Section 2, no sensitive environmental resources are present at the facility. Therefore, *no significant impacts* to existing environmental conditions resulting from the proposed action are expected.

3.1.2 Thiokol Corporation

As previously stated, LEAP program activities at the Thiokol Corporation will occur within the context of routine operations at the facility. No facility construction or modification will be required to support the activities. Required environmental and safety permits, including a RCRA permit, are maintained and current. Although wetlands, aquifers, and floodplains are located on the 500 acre facility, these resources will not be affected by LEAP program activities. Therefore, *no significant impacts* to existing environmental conditions resulting from the proposed action are expected.

3.2 Proposed Action - Pre-flight and Flight Test Locations

This section evaluates the proposed action at the specific pre-flight and flight test locations (White Sands Missile Range, Kwajalein Missile Range at USAKA, and Wake Island). Each facility was evaluated relative to environmental resources potentially affected by program changes that were not evaluated in the LEAP EA. The environmental resources examined at the facilities included physical setting and man-made environment; water resources; geology and soils; biological resources; threatened and endangered species; cultural resources; air quality; noise; infrastructure; and public health and safety. For each of these resource areas at each location, potential impacts from the proposed action were evaluated separately for construction and test activities.

3.2.1 White Sands Missile Range (WSMR)

As identified in Sections 1 and 2, the modification to the LEAP-3 flight at WSMR will not affect existing conditions differently than those identified in the LEAP EA and FONSI. The new trajectory/azimuth will be identical to the trajectory/azimuth for LEAP-1/-2. Only 3.5 pounds of Hydroxyl Terminated Polybutadiene (HTPB) and ammonium perchlorate will be used as LEAP projectile propellant on the LEAP-3 test flight. The LEAP-3 launch, using an Aries I LEAP Launch Vehicle, will carry 10,370 pounds of solid propellant. The principal combustion products of HTPB are CO_2, N_2, H_2, H_2O, and HCl, which are also combustion products of the Aries I and were assessed in the LEAP EA (Ref #41). The addition of 3.5 pounds of propellant, with the same combustion products, represents an increase of less than one-tenth of one percent in pollutants from the flight. These impacts are within the scope of the original LEAP EA analysis and FONSI (Ref #32). All WSMR flights, including LEAP-3 and modifications, will be conducted in accordance with the LEAP EA and mitigation measures identified therein. Therefore, *no significant impacts* to any of the environmental resources evaluated in the LEAP EA are expected.

3.2.2 Kwajalein Missile Range (KMR), USAKA

The USAKA Environmental Impact Statement and subsequent Record of Decision were incorporated into the LEAP EA by reference. As stated in the LEAP EA, all LEAP test program activities are required to adhere to the mitigation measures included in the USAKA EIS. This

requirement is identical for all program modifications identified in Section 1 of this document. The following sections provide a brief summary of potential consequences at USAKA resulting from proposed modifications to the LEAP program.

3.2.2.1 Physical Setting and Land Use

The LEAP test program modifications will not alter land uses at USAKA. Construction and structural modifications at the facility will be minor, consisting primarily of interior renovation of the facilities. The program modifications are consistent with the present use and condition of the facility. Adjacent land uses will not be altered by the LEAP program activities. Therefore, *no significant impacts* to the physical setting of the area and land uses are anticipated from the LEAP program.

3.2.2.2 Geology and Water Resources

The LEAP EA illustrated that no potentially significant impacts to geology or water resources were likely as a result of the proposed action. The proposed modifications to the test program will not affect these resources differently than what is described in the LEAP EA; therefore, *no significant impacts* to geology and water resources are anticipated.

3.2.2.3 Air Quality

Both a programmatic and site-specific discussion of the effects on air quality from the LEAP program were presented in the LEAP EA. Air modeling analyses for the original document included emissions from a normal launch and emissions from a launch accident scenario. National Ambient Air Quality Standards (NAAQS), American Conference of Government Industrial Hygienists (ACGIH) and the Occupational Safety and Health Administration (OSHA) guidelines and standards were used as the comparison values in the analysis (Ref #32).

The programmatic discussion presented a detailed description on the potential effects of hydrogen chloride (HCl) on the environment, with the finding that HCl deposition would not lead to significant impacts on biological or aquatic resources. Hydrogen chloride is an exhaust product of solid rocket propellants used on the Aries Launch Vehicles, the ASAS propulsion motor, and a modified LEAP projectile. Hydrogen chloride is also an exhaust product of liquid propulsion systems, including ClF_5. Hydrogen chloride contains chlorine, which is suspected as a contributor to ozone depletion (Ref #54).

The impact of chlorine produced by solid rocket motors on stratospheric ozone was studied by NASA and included representatives of the NASA Goddard Institute of Space Studies and the NASA Goddard Space Flight Center. The study modelled the impacts of nine Space Shuttle and six Titan IV launches per year, which comprise the largest potential source of stratospheric chlorine from the United States space fleet. The findings of the study were that regional or global impacts to ozone from the launches would not be significant. These findings are consistent

with modelling efforts done at five different research centers to assess stratospheric ozone depletion by the Space Shuttle for the Space Shuttle EIS (NASA, 1978) (Ref #54).

The ASAS solid propellant axial propulsion motor uses the same solid propellant as the Aries I (10,370 pounds) and Aries II (3,665 pounds) LEAP Launch Vehicles. The total weight of propellants on the booster configurations for USAKA launches will total 14,035 pounds (Ref #32). The total weight of the ASAS propulsion motor is approximately 128 pounds when loaded with propellant (Ref #41). Assuming the solid propellants comprise the total weight of the motor, it would still comprise less than 1 percent of the total propellants on the launch vehicle. Therefore, emissions from the addition of the ASAS would increase total emissions less than 1 percent above previously assessed quantities. A thorough air modeling analysis of the combustion products of the LEAP launches was presented in the July 1991 LEAP EA. Therefore, emissions from the ASAS propulsion motor will be well below any level that would have a significant impact on air quality.

The amount of chlorine emitted into the stratosphere by an Aries Launch Vehicle is less than 1 percent of the chlorine emitted by a single Space Shuttle launch. The Aries Launch Vehicle configurations for LEAP-X and LEAP-7 are the same as those originally addressed in the LEAP EA. Therefore, LEAP test program launches are not anticipated to have a significant impact on stratospheric ozone depletion.

Under normal flight test operations, all ClF_5 emission products will be expelled in the exoatmosphere. In the event of a catastrophic failure during flight, the ClF_5 will be consumed with other propellants on the booster. The emissions under this scenario are presented in the LEAP EA. As previously identified, the AFTOX model illustrates that in an accidental ground release, 45 pounds of ClF_5 (the maximum quantity to be used at KMR) would react with the atmosphere and moisture to form 37.4 pounds hydrogen fluoride (HF) and 13.2 pounds chlorine (Cl). A release of 13 pounds of chlorine to the atmosphere represents less than 1 percent of the total annual chlorine emissions from the Space Shuttle and Titan IV model cited above. As identified in Section 1.0, the ClF_5 loading system to be used at USAKA is similar to the system that has been used at Aerojet for five years without incident. The system undergoes a full integrity check before loading operations. All residual material at USAKA will be treated in Aerojet's charcoal reactor system, creating an inert material. Moreover, only one gallon of ClF_5 will be shipped in the 2.5 gallon HOKE bottles, precluding the risk of an accidental release of material. Since emissions from the additional launches are similar to those already assessed, and a catastrophic event on the ground is extremely unlikely, *no significant impacts* to air quality are anticipated.

3.2.2.4 Noise

As identified in the LEAP EA, all LEAP launches at USAKA will follow mission profiles that were assessed in the USAKA EIS and LEAP EA. The proposed program modifications and the addition of LEAP-X and LEAP-7 will also conform to these analyses presented in those

documents. Standard Safety Operating Procedures, as discussed in the LEAP EA, will preclude noise/hearing impacts to personnel during test and launching activities. The USAKA EIS identifies no sensitive receptors in the receptor distances for primary noise generating sources at Meck Island. Therefore, *no significant impacts* from program generated noise are anticipated.

3.2.2.5 Biological Resources

As identified in the LEAP EA, all LEAP test program activities will adhere to the mitigation measures identified in the USAKA EIS and subsequent Record of Decision. Moreover, modifications to the program, including the addition of LEAP-X and LEAP-7, will not result in disturbance to previously undisturbed areas. The telemetry equipment to be placed on Roi-Namur will be placed on existing areas previously used for that purpose. No specific mitigation measures were necessary in the LEAP EA to protect biological resources at USAKA. Therefore, *no significant impacts* to biological resources resulting from LEAP program modifications are anticipated.

3.2.2.6 Threatened and Endangered Species

Mitigation measures to protect threatened and endangered species at USAKA are outlined in the USAKA EIS. As stated in the LEAP EA, all LEAP test program activities will adhere to these mitigations. The LEAP EA includes no specific mitigations to protect these species at USAKA. Therefore, *no significant impacts* to threatened or endangered species, or their habitat, resulting from LEAP program modifications are anticipated.

3.2.2.7 Cultural Resources

Modifications to the LEAP test program at USAKA will not require any ground disturbance or permanent alteration of existing structures. The test program activities will adhere to all mitigation measures in the USAKA EIS designed to protect cultural resources. No specific mitigation measures were identified as necessary in the LEAP EA to protect these resources. Therefore *no significant impacts* to cultural resources are anticipated from the LEAP program modifications.

3.2.2.8 Infrastructure

As identified in the LEAP EA, specific mitigation measures to protect the existing infrastructure at USAKA were not necessary to prevent potentially significant impacts. The modifications to the LEAP program will not require modifications to the existing infrastructure. The numbers of LEAP test program personnel have not changed significantly to support the program modifications. Therefore, impacts on housing conditions, transportation facilities, water treatment facilities, etc., will not be significantly different than the impacts identified in the LEAP EA. Therefore, *no significant impacts* to the existing infrastructure at USAKA are anticipated from LEAP test program activities.

3.2.2.9 Hazardous Materials and Wastes

As identified in the LEAP EA, handling of all hazardous materials and wastes will be done in accordance with the USAKA EIS and Record of Decision. All hazardous wastes resulting from the program will be removed from USAKA. No specific measures not already included in the project description, were identified as necessary to prevent impacts from hazardous materials and wastes in the LEAP EA. Therefore, *no significant impacts* resulting from hazardous materials or wastes are anticipated.

3.2.2.10 Public Health and Safety

As identified in the LEAP EA, activities supporting the LEAP test program will be consistent with previous missions at USAKA, and will be conducted within existing regulations, which provide safety to personnel. As illustrated in Section 1.2.5, six separate safety documents have been produced which regulate all aspects of handling hazardous propellants during test and launch operations. The Air Force Toxic Dispersion Model has identified hazards associated with an accidental release of propellants. The model identifies safety corridors which are built in to the Standard Safety Operating Procedures to protect civilians and personnel during transportation, storage, and handling of these materials. In addition, all LEAP test program activities will be conducted in accordance with the USAKA EIS Record of Decision. Therefore, *no significant impacts* to human health and safety are anticipated.

3.2.3 Wake Island

As previously stated, target launch vehicles supporting the LEAP test program will be launched from Wake Island. Target launches using the Castor IVA boosters for LEAP-5 and LEAP-6 were assessed in the LEAP EA. The only change in program activities at Wake Island is the addition of one more target launch to support the LEAP-7 launch. As identified in Section 2, the program modifications will not affect existing conditions differently than those assessed in the LEAP EA. Therefore, *no significant impacts* from modifications to the LEAP program are anticipated at Wake Island.

3.3 No Action Alternative

As stated in Section 1.7.3, the no-action alternative in this instance is to have the LEAP test program proceed as analyzed in the LEAP EA. Proposed modifications to the program would not be implemented, and the additional launches would not take place. No potentially significant impacts resulting from the LEAP test program are identified in the LEAP EA; therefore the selection of the no-action alternative would present no significant environmental impacts.

3.4 Cumulative Impacts

Cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action regardless of what agency (Federal or non-Federal) or person undertakes such other actions." (40 CFR Part 1508.7).

As identified in the LEAP EA, no cumulative impacts from the LEAP test program are anticipated for any of the test locations where these activities will occur. Meck Island will only support two programs at a time, precluding exceedance of design standards of the facility. All government and private contractor facilities participating in the LEAP test program are required to comply with Federal, state, and local regulations which guarantee the maintenance and integrity of environmental resources. These regulations include, but are not limited to the:

- National Environmental Policy Act (NEPA);
- Clean Air Act;
- Clean Water Act of 1977;
- Resource Conservation and Recovery Act of 1976;
- Toxic Substances and Control Act; and
- Comprehensive Environmental Response, Compensation and Liability Act of 1980.

Compliance with these regulations contributes to the insurance that LEAP test program activities will not contribute to cumulative impacts on the environment. The primary change in the program since the LEAP FONSI in July 1991 is the addition of the use of ClF_5 at KMR. The oxidizer will not require the construction of facilities to accommodate its use at the range. Procedures for handling the material are very similar to those procedures implemented for other activities. Although the material is defined as hazardous, it will be used in very small quantities by individuals and organizations who handle the material routinely. Therefore, no cumulative impacts will result from the use of the material for the LEAP program.

3.5 Relationship Between Short-Term Use of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

Proposed modifications to the LEAP test program largely involve the use of existing facilities and resources. As identified in Section 1, private contractors involved in the program will use existing structures and facilities to support their program activities. In addition, LEAP pre-flight and flight test activities will occur at USAKA and Wake Island. These facilities are dedicated primarily to programs and activities of this nature; consequently, the proposed modifications to the LEAP test program will result in no net loss of any significant environmental resources (e.g., prime agricultural land, wetlands, historical properties) or significant amounts of natural resources.

3.6 Irreversible or Irretrievable Commitment of Resources

Implementing the proposed modifications to the LEAP test program will result in no impact on threatened or endangered resources, or archaeological or historic properties. In addition, the action will not result in changes in land use or cause loss of habitat for plants or animals.

Irretrievable commitment of some resources will be required to support the program. The resources would include raw materials to fabricate the various components of the LEAP-X and LEAP-7 launch vehicles and support systems. This commitment will be small-scale in nature, and not substantively different from similar activities carried out on a routine basis.

3.7 Conflicts with Federal, Regional, State, Local, or Indian Tribe Land Use Plans, Policies, and Controls

All activities to support the proposed modifications to the LEAP test program, at both private and government facilities, will occur within existing areas and structures previously used for similar purposes. All activities at private contracting facilities are in compliance with local plans and ordinances. Pre-flight and flight test activities (not addressed in the LEAP EA) will take place at USAKA and Wake Island. Similar activities have occurred at these facilities and pose no threat to Tribal land or surrounding land uses.

Agencies and Persons Consulted 4.0

4.0 List of Agencies and Persons Consulted

U.S. Army Kwajalein Atoll Office of Environmental Compliance
United States Army Kwajalein Atoll

U.S. Fish and Wildlife Service
Pacific Island Office
Honolulu, Hawaii

National Marine Fisheries Service
Pacific Area Office
Honolulu, Hawaii

Sam Wiley
Aerojet
ALAS Project Engineer

Catherine Simonsen
Senior Environmental Analyst
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Eric Motz
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Russ Evans
Aerojet
Environmental Analyst

Rick Polleck
Thiokol Corporation
ASAS Program Manager

Keith Flint
LEAP Range Operations
Space Experiments Directorate
Phillips Laboratory

Kenneth Sims
U.S. Army Strategic Defense Command
USASDC-EN-V
Huntsville, Alabama

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Office
P.O. Box 50167
Honolulu, Hawaii 96850

May 1, 1992

Mr. Crate J. Spears
Environmental Coordinator
SDIO-TNE
The Pentagon
Washington, D.C. 20301-7100

Dear Mr. Spears:

This follows up on our meeting of earlier today regarding the Lightweight ExoAtmospheric Projectile (LEAP) test program to be conducted on Meck Island, Kwajalein, Republic of the Marshall Islands. You provided us a copy of the April 1992 Draft Supplemental Environmental Assessment for the LEAP program and a letter (April 24, 1992) requesting our comments on how the project may affect animal and plant species within the U.S. Fish and Wildlife Service's jurisdiction.

In March 1991 we reviewed the initial project and determined that the LEAP program would not affect any species of animals or plants or other resources within this Service's jurisdiction, including endangered and threatened species. Although some aspects of the LEAP program have since been modified, we concur with your determination that the LEAP program, as described in the April 1992 Draft Supplemental Environmental Assessment and related documents, will have no effect on species within this Service's jurisdiction.

Thank you for the opportunity to comment on the project. If we can be of any additional assistance, please contact us again.

Sincerely,

William R. Kramer
William R. Kramer
Acting Field Supervisor
Pacific Islands Office

cc: L.D. Walker, Director, Environmental Services, Louis Berger & Associates, Inc., Washington, D.C.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Area Office - Southwest Region
2570 Dole St. Honolulu, HI 96822-2396
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May 4, 1992 F/SW023:JJN

Mr. Crate Spears
SDIO Environmental Coordinator
SDIO/TNE
The Pentagon, Room 1E180
Washington, D.C. 20301-7100

Dear Mr. Spears:

The National Marine Fisheries Service (NMFS) has reviewed the proposal by the Strategic Defenses Initiative Organization (SDIO) to modify the Lightweight ExoAtmospheric Projectile (LEAP) program on Meck Island, U.S. Army Kwajalein Atoll (USAKA). Our review included a meeting with SDIO and project contract personnel, as well as a review of the draft Environmental Assessment (EA) for the proposed modifications. We offer the following comments for your consideration.

It is our understanding that the purpose of the LEAP program is to design, develop, and demonstrate the capability of a lightweight projectile to intercept targets in the exoatmospheric region. The proposed program modification would use existing facilities and the same type of Aries rocket boosters used in previous launches. The proposal modifications include:

- The flight trajectory for the LEAP-3 test flight has been modified to emulate the trajectories for LEAP-1 and LEAP-2.

- LEAP launches at Meck Island at Kwajalein Missile Range (KMR) in USAKA are now to occur from the facility on the southern portion of Launch Hill.

- An additional launch, LEAP-X, is planned to occur at KMR. The flight test is a single-rocket launch from Meck Island.

- The Advanced Liquid Axial State (ALAS) light propellant rocket motor has been added as the LEAP projectile propulsion system for the LEAP-X and LEAP-6 flights at KMR. The system will include the use of chlorine pentaflouride (CIF_5) as the liquid oxidizer.

- An additional launch, LEAP-7, is planned to occur at KMR. The test flight is a two-rocket launch from KMR and Wake Island.

- The Advanced Solid Axial State (ASAS) solid propellant rocket motor has been added as the LEAP projectile propulsion system for the LEAP-7 flight.

Activities to support the LEAP program are still planned to occur at the facilities identified in the LEAP EA. In addition, component assembly activities will be performed at Aerojet, Sacramento, California and Thiokol Corporation, Elkton, Maryland.

NMFS reviewed and commented on the original LEAP program through our review of the program Draft EIS(report to SDIO dated April 8, 1991). Our concerns stated in the early report were discussed with project personnel at a meeting on May 1, 1992 in Honolulu. In view of these discussions, and our review of the project EA, NMFS feels the proposal modifications will have no significant impact on those living marine resources and habitats which fall under our jurisdiction.

Sincerely,

John J. Naughton
Pacific Islands
Environmental Coordinator

cc: F/SWO - Long Beach, CA
FWS, Honolulu
EPA, Region 9 (E-4)
Corps of Engineers, Honolulu

Glossary and Acronyms 5.0

5.0 Glossary and Acronyms

ABM	Anti-Ballistic Missile
ACGIH	American Conference of Governmental Industrial Hygienists
ACHP	Advisory Council on Historic Preservation
ACS	Attitude Control Subsystem
AFATL	Air Force Armament and Test Laboratory
AFB	Air Force Base
AFSTC	Air Force Space Technology Center
AL	Aluminum
ALAS	Advanced Liquid Axial Stage
ALIVE	Army LEAP Integrated Validation Experiment
AR	Army Regulation
ARDEC	Armament Research Development Engineering Command
ARMTE	Army Material Test and Evaluation Directorate
ASAS	Advanced Solid Axial Stage
BAE	Boeing Aerospace and Electronics
B_2H_6	Diborane
BEH	Beryllium Hydride
BLM	Bureau of Land Management
CCAFS	Cape Canaveral Air Force Station
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
ClF_5	Chlorine Pentaflouride
CH_4	Methane
CG	Center of Gravity
C_3H_8	Propane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CONUS	Continental United States
CST	Combined System Test
db	Decibel
dBA	Decibel (A-weighted)
DNL	Day/Night Noise Level
DA	Department of Army
DoD	Department of Defense
DOE	Department of Energy
DOPAA	Description of Proposed Action and Alternatives
DOT	U.S. Department of Transportation

E^2I	Endo/Exoatmospheric Interceptor
EA	Environmental Assessment
ECIS	Environmental Critical Issues Summary
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERIS	Exoatmospheric Reentry Vehicle Interceptor System
ESQDs	Explosives Safety Quantity Distances
F	Fahrenheit
FLOX	Fluoridated Oxidizers
FONSI	Finding of No Significant Impact
GBFEL-TIE	Ground Based Free Electron Laser Technology Integration Experiment
GFE	Government Furnished Equipment
GN_2	Cold Gas Nitrogen
GSTS	Ground-Based Surveillance and Tracking System
H_2	Hydrogen
HAC	Hughes Aircraft Company
HCl	Hydrogen Chloride
HEDI	High Endoatmospheric Defense Interceptor
HF	Hydrogen Fluoride
HPP	Historic Preservation Plan
HTPB	Hydroxyl Terminated Polybutadiene
IMU	Inertial Measuring Unit
IR	Infrared
KEW	Kinetic Energy Weapons
KFIT	Kinetic Flight Integration Test
KHIT	Kinetic Hover Interceptor Test
km	Kilometer
KMR	Kwajalein Missile Range
kW	Kilowatt
LAE	LEAP Auxiliary Equipment
lbm	Pounds Mass
LC	Launch Complex
L_{eq}	Average Sound Level
Ldn	Day-Night Average Sound Level
LEAP	Lightweight Exoatmospheric Projectile
LEB	Launch Equipment Building
LF_2	Lithium Difluoride
LIFE	Lightweight Exoatmospheric Projectile Integrated Flight Experiment
LN_2	Cryogenic Liquid Nitrogen
LOCC	Launch Operations Control Center
LONOTES	Local Notices to Mariners
LSB	Launch Support Building

LSE	Launch Support Equipment
MAB	Missile Assembly Building
MFSOP	Missile Flight Safety Operational Plan
mg/m^3	Milligrams Per Cubic Meter
mg/l	Milligrams Per Liter
MGTS	Mobile Ground Tracking System
MICB	Meck Island Control Building
MMH	Monomethylhydrazine
MOA	Memorandum of Agreement
MOI	Moment of Inertia
MOCF	Mission Operations Checkout Flight
MRTFB	Major Range Testing Facility Base
MSL	Mean Sea Level
MWIR	Medium Wave Infrared
N_2	Nitrogen
N_2O_4	Nitrogen Tetroxide
N_2H_4	Hydrazine
N_2F_4	Nitrogen Tetrafluoride
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NEW	Net Explosive Weight
NHTF	National Hover Test Facility
NIOSH	National Institute of Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NCOIC	Noncommissioned Officer in Charge
NOMTS	Naval Ordnance Missile Test Station
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRO	National Range Operations
OF_2	Oxygen Difluoride
OIC	Officer in Charge
OSC	Orbital Sciences Corporation
OSHA	Occupational Safety and Health Administration
PAB	Payload Assembly Building
PBV	Post Boost Vehicle
PCB	Polychlorinated Biphenols
PL	Phillips Laboratory
PM	Payload Module
PMB	Payload Module Bus
PM10	Particulate Matter Less Than 10 Microns in Diameter
PPM	Parts Per Million

PMOA	Programmatic Memorandum of Agreement
POL	Petroleum Oil and Lubricants
PTL	Probe Testing Laboratory
PWL	Sound Power Level
RCRA	Resource Conservation and Recovery Act
RMI	Republic of the Marshall Islands
ROD	Record of Decision
ROI	Region of Influence
RSO	Range Safety Officer
RV	Reentry Vehicle
SBI	Space Based Interceptor
SCBA	Self Contained Breathing Apparatus
SCS	Soil Conservation Service
SDD	Space Data Division
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization
SDS	Strategic Defense System
SHPO	State Historic Preservation Officer
SOP	Standard Operating Procedure
SPL	Sound Pressure Level
SSOP	Safety Standing Operating Procedures
STP	Space Test Projectile (LEAP projectile)
TBAM	Target Booster Assist Module
TECOM	U.S. Army Test and Evaluation Command
TLV	Threshold Limit Value
TM	Technical Manual
TNS	Sensor and Interceptor Technology Directorate
TVP	Technology Validation Program
USAKA	U.S. Army Kwajalein Atoll
USASDC	U.S. Army Strategic Defense Command
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	Ultraviolet
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility (NASA)

References 6.0

6.0 References

1. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ClF_5 Loading System Fueling Area and Control Room Setup Procedure, APD-LEAP-X-230".*

2. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ClF_5 Loading System Leak Check and Functional Checkout Procedure, APD-LEAP-X-220".*

3. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ClF_5 Loading System Receive and Inspect Procedure, APD-LEAP-X-210".*

4. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ClF_5 Loading System Procedures Index, APD-LEAP-X-200".*

5. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ALAS LEAP X FV Oxidizer and Nitrogen Loading Procedure (Haz Ops), APD-LEAP-X-240".*

6. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ALAS LEAP X FV Oxidizer and Nitrogen Off-Loading Procedure (Haz Ops), APD-LEAP-X-250".*

7. Aerojet Propulsion Division, February 28, 1992. *"ALAS LEAP X Flight Experiment: ClF_5 Loading System Emergency Procedures for Equipment Failure (Haz Ops), APD-LEAP-X-260".*

8. Aerojet Propulsion Division, March 1, 1992. *"ALAS LEAP X Procedures".*

9. Aerojet Propulsion Division, October 1990. *"A Versatile Chlorine Pentafluoride / Hydrazine Altitude Rocket Engine Test Facility."*

10. Aerojet TechSystems Company, December 10, 1987. *"Recent Development in the Design and Testing of a Space Based Liquid Booster."*

11. Aerojet TechSystems Company, July 1986. *"Propellant Selection Considerations for Space Based Liquid Boosters."*

12. Aerojet TechSystems Company, June 1989. *"The Synthesis of an ALAS Using Cost as a Figure of Merit."*

13. Cubbison, Douglas R. Memorandum, October 4, 1991. *"Draft Chlorine Pentafluoride Description of Proposed Action and Alternatives."*

14. Cubbison, Douglas R., Teledyne Brown Engineering, September 30, 1991. *"Use of Chloride Pentafluoride as a Liquid Oxidizer for Flight Test Experiments Launched from Meck Island, USAKA".*

15. Cubbison, Douglas R. Telefax Communication including Trip Report/Meeting Minutes, October 25, 1991. *"LEAP Payloaders Hazardous Ground Operations Meeting on October 24, 1991 at Phillips Laboratory."*

16. Dickey, Captain Michael. Memorandum, January 14, 1992. *"LEAP Supplemental EA Information Requirements".*

17. Dickey, Captain Michael. Memorandum, March 16, 1992. *"Comments on Draft DOPAA - LEAP-X Supplemental EA."*

18. Dickey, Captain Michael. Telefax Communication, January 21, 1992, *"ClF_5 Transport From PL" Briefing Slides".*

19. Dickey, Captain Michael. Telefax Communication, January 31, 1992. LEAP Environmental Data, *"EA Supplement Kickoff Meeting Action Items".*

20. Dickey, Captain Michael. Telefax Communication, March 19, 1992, *"Procedures at Kwajalein for LEAP Outlining Scheduled Activities and Launch Flow".*

21. Dickey, Captain Michael. Telefax Communication, March 19, 1992, *"ALAS/ASAS Motor Alternatives, LEAP X Hazardous Operations Procedures Summary and Field Operations Calendar".*

22. Dickey, Captain Michael. Telefax Communication, March 24, 1992. *"Dispersion Areas for the LEAP Launches at Kwajalein Missile Range."*

23. Knox, Robert R. III, SDI Project Officer. Memorandum, December 4, 1991. *"The Logistics Impact of Selecting Chlorine Pentafluoride (ClF_5) as an Oxidizer".*

24. Lampiasi, Dennis A. Memorandum, November 19, 1991. *"KMR Site Visitation LEAP X, 5 & 6 from November 11 - 15, 1991."*

25. National Hover Test Facility, Phillips Laboratory, Edwards AFB, California, March 5, 1992. *"Technical Operating Procedure: ALAS Hydrazine Transfer Cart Operations, Procedure Number KMR-LEAP-X-TOP-351".*

26. Orbital Sciences Corporation/Space Data Division, January 31, 1992. *"SDIO Flight Test Services Program (FTSP) LEAP-X Range Safety Data Package (RSDP) for Kwajalein Missile Range, Preliminary Draft.*

27. Orbital Sciences Corporation/Space Data Division, February 24, 1992. *"Facilities Requirements Document: LEAP X, 5 & 6".*

28. Orbital Sciences Corporation/Space Data Division, December 18, 1991. *"SDIO Flight Test Services Program (FTSP) LEAP-X Flight Test Plan Per CDRL A006, Preliminary Draft".*

29. Orbital Sciences Corporation/Space Data Division, October 16, 1991. *"SDIO Flight Test Services Program (FTSP) LEAP-X, 5 & 6 Program Requirements Document".*

30. Orbital Sciences Corporation/Space Data Division, Meeting Minutes, March 4, 1992 at Chandler, Arizona. *"LEAP-X SSWG March 3 & 4 1992 Meeting".*

31. Orbital Sciences Corporation, Space Data Division. *"GN&C Vehicle Design LEAP-X, -5LLV and TLV."*

32. Strategic Defense Initiative Organization, July, 1991. *"Lightweight Exoatmospheric Projectile (LEAP) Test Program Environmental Assessment."*

33. Strategic Defense Initiative Organization. Meeting Minutes, January 7, 1992, 1:00 p.m. at SDIO/TNE LEAP Program Office. *"Kickoff Meeting to Launch EIAP for Supplemental LEAP EA".*

34. Strategic Defense Initiative Organization. Meeting Minutes, March 16, 1992 at the LEAP Program Office at Pentagon.

35. Theriault, LtCol Steve. Telefax Communication, February 7, 1992. *"Graphics and Flight Description of the LEAP 7 Flight Test."*

36. U.S. Army Corps of Engineers, Pacific Ocean Division, April 1988. *"Master Plan Report: Concept Plans, Future Development Plan and Utilities Analysis".*

37. Wiley, Sam, Aerojet Propulsion Division. Memorandum, February 7, 1992. *"LEAP ALAS Loading Configuration at Building 5103 on Meck Island".*

38. U.S. Army Strategic Defense Command. 1989. *"Environmental Assessment, High Endoatmospheric Defense Interceptor (HEDI) Technology Testing Program."*

39. Aerojet Propulsion Division, April 17, 1992. *"Standard Environmental Questions for Contractor".*

40. Thiokol Corporation, April 16, 1992. *"Standard Environmental Questions for Contractor".*

41. Thiokol Corporation. Memorandum, April 17, 1992. *"Environmental Issues Survey - Supplemental Information on ASAS".*

42. Thiokol Corporation. Memorandum, April 17, 1992. *"Environmental Issues Survey - MSDS".*

43. U.S. Army Strategic Defense Command. May 22, 1989. *"Environmental Impact Statement, Proposed Actions at U.S. Army Kwajalein Atoll (USAKA)."*

44. U.S. Army Strategic Defense Command. 1989. *"U.S. Army Kwajalein Atoll (USAKA) Record of Decision."*

45. Aerojet Propulsion Division, Sacramento California. April 1992. *"ALAS LEAP-X Early Flight Experiment - Combined System Test (CST) Overview, Flight Vehicle Propellant Servicing."*

46. Aerojet Propulsion Division, Sacramento, California. April 16, 1992. *"ALAS LEAP-X Combined System Test (CST) Critical Experiment Review (CER), Number 10151."*

47. Phillips Laboratory, Edwards AFB, California. April 28, 1992. *"LEAP-X Propellant Operations at KMR: Hydrazine and Chlorine Pentaflouride (ClF_5)", presented to USAKA by Phillips Laboratory (OLAC) and Wyle Laboratories.*

48. Wyle Laboratories, John Marshall. April 28, 1992. *"LEAP-X Support ClF_5 Shipment to Kwajalein Island, Echo Pier and Meck Island Storage."*

49. Marshall, John, Wyle Laboratories. April 23, 1992. *"Memorandum: Transmittal of Data Sheets, Shipment of Chlorine Pentaflouride (UN#2548) Cylinders to Echo Pier, Kwajalein Island."*

50. Dickey, Captain Michael. Memorandum, April 29, 1992. *"Ultraseek Description." Technical memorandum outlining design specifics and technical information regarding the Ultraseek Advanced Technology Unit.*

51. Thibault, Steve, ANSER. Memorandum, May 1, 1992. *"LEAP EA Trajectory Methodology."*

52. Phillips Laboratory, Edwards AFB, California. March 10, 1992. *"Memorandum from Keith Flint: Chlorine Pentafluoride Hazard and Compatibility Group Information."*

53. Phillips Laboratory, Edwards AFB, California. April 18, 1992. *"Memorandum from Keith Flint: Air Force Dispersion Model as Presented to KMR Safety."*

54. Strategic Defense Initiative Organization. January 1992. *"Draft Environmental Planning Technical Report."*

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8.0 Distribution

8.1 Department of Defense Agencies

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Federal Express/DHL
1941 Jefferson Davis Highway
Crystal Mall 4, Suite 900
Arlington, VA 22215-0280
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Department of the Army
Office of the Surgeon General
5 Skyline Place
5111 Leesburg Pike
Falls Church, VA 22041

Department of the Navy
Deputy Director for Environment
Office of Director of Installations and Facilities
Crystal Plaza, Bldg. 5
Arlington, VA 20360

U.S. Army Environmental Hygiene Agency
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MD 21010-5442

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Attn: Keith Flint
Edwards AFB, CA 93523-5000

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106 Wynn Drive
Huntsville, AL 35805
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10th & Pennsylvania Avenue, NW
Washington, DC 20530

Safety and Occupation Health Division
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(CP-45)
Crystal Plaza, Bldg. 5
Arlington, VA 20360

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401 M Street, SW
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Washington, DC 20460

Council on Environmental Quality
722 Jackson Place, SW
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Washington, DC 20503

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U.S. Environmental Protection
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Office of Public Affairs
Department of Interior
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Washington, DC 20240

National Security Council
Old Executive Office Building
Room 389
Washington, DC 20506

Arms Control and Disarmament Agency
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320 21st Street, NW
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Majuro, Marshall Islands 96960

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Aerojet Propulsion Division
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Appendix
Propellant Safety Data Sheets

A

ELF ATOCHEM

EMERGENCY PHONE: (918) 583-0851
CHEMTREC PHONE: (800) 424-9300

OZARK-MAHONING

FLUORINE SPECIALTIES DEPARTMENT
PERFORMANCE PRODUCTS DIVISION
5101 WEST 21ST STREET, TULSA, OK 7410

MATERIAL SAFETY DATA SHEET

PRODUCT: 6730 CHLORINE PENTAFLUORIDE DATE 01-02-9

PRODUCT NAME	Chlorine Pentafluoride
SYNONYMS	None
CHEMICAL NAME	Chlorine Pentafluoride
MOLECULAR FORMULA	ClF_5
CHEMICAL FAMILY	Inorganic Fluorides

INGREDIENTS - HAZARD CLASSIFICATIONS

This product contains the following toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372:

COMPONENTS-HAZARDOUS	CAS NO.	%
Chlorine Pentafluoride	13637-63-3	99-100

SHIPPING INSTRUCTIONS

Chlorine Pentafluoride, Non-flammable Gas, UN2548, Poison-Inhalation Hazard, Hazard Zone
Shipment forbidden by Air and UPS.

PHYSICAL PROPERTIES

BOILING POINT/RANGE -13.1° C	MELTING POINT -103° C	FREEZING POINT -103° C
MOLECULAR WEIGHT 130.5	SPECIFIC GRAVITY (H_2O = 1) NE	VAPOR PRESSURE (MM HG) NE
VAPOR DENSITY (AIR = 1) NE	SOLUBILITY IN H_2O Reacts Violently	% VOLATILES BY VOLUME 100
APPEARANCE AND ODOR Colorless gas		

FIRE AND EXPLOSION DATA

FLASH POINT	FLAMMABLE LIMITS	AUTOIGNITION TEMPERATUR
NA	NA	NA

EXTINGUISHING MEDIA
CO_2 Dry Chemical Water Spray

SPECIAL FIRE FIGHTING PROCEDURES
NA

UNUSUAL FIRE AND EXPLOSION HAZARDS
NA

REACTIVITY DATA

STABILITY	CONDITIONS CONTRIBUTION TO INSTABILIT
Stable	NA

INCOMPATIBILITY - Avoid contact with strong acids.

NA - NOT APPLICABLE NE - NOT ESTABLISHED

THE HERITAGE: PENNWALT, M & T, AND ATOCHEM, INC.

ELF ATOCHEM OZARK-MAHONING

MATERIAL SAFETY DATA SHEET

PRODUCT: 6730 CHLORINE PENTAFLUORIDE DATE 01-02-92

HAZARDOUS DECOMPOSITION THERMAL AND OTHER
Contact with acids may produce HF which is a highly toxic and corrosive material.

CONDITIONS TO AVOID NA

TOXICITY

ROUTE	ANIMAL	DATA
INHALATION	Rat	LC50; 122 ppm/1 H
INHALATION	Mus	LC50; 56 ppm/1 H
INHALATION	Mky	LC50; 122 ppm/1 H

EYE EFFECTS Irreversible corrosion.

SKIN EFFECTS Corrosive

OTHER TOXIC EFFECTS A very large dose or prolonged exposure may cause fluorosis (bone damage), and kidney or liver damage. Inhalation of dust may cause irritation of the respiratory tract, pulmonary edema, congestion and fluorosis (bone damage).

TARGET ORGAN TOXIN Eye, Skin, Kidney, Liver, Lung, Bone

TOXICITY COMMENTS See above.

HEALTH HAZARD INFORMATION

PERMISSIBLE EXPOSURE LIMITS
ACGIH TLV® for fluorides as F^- = 2.5 mg/m³ 1989-90.

EMERGENCY FIRST AID

INGESTION This is a gas.

DERMAL Flush with water for at least 15 minutes.

EYE CONTACT Flush with water for at least 15 minutes. Seek emergency medical attention.

INHALATION In case of respiratory difficulty, seek emergency medical attention.

SPECIAL PROTECTION INFORMATION

VENTILATION REQUIREMENTS Local exhaust. Use with adequate ventilation.

EYE Safety glasses

HAND (GLOVE TYPE) Polyvinyl Chloride, Natural Rubber, Polyethylene

RESPIRATOR TYPE Filter dust, fume, mist

OTHER PROTECTIVE EQUIPMENT NA

NA - Not Applicable NE - Not Established

THE HERITAGE: PENNWALT, M & T, AND ATOCHEM, INC.

Atch 1²

MATERIAL SAFETY DATA SHEET

PRODUCT: 6730 CHLORINE PENTAFLUORIDE DATE 01-02-92

SPECIAL HANDLING AND STORAGE CONDITIONS

Wash thoroughly after handling.
Do not get in eyes, on skin or clothing.
Do not breathe dust, vapor, mist, or gas.
Contact with acid may release toxic vapors (HF) which causes burns.

SPILL MANAGEMENT

SPILL, LEAK AND DISPOSAL PROCEDURES

Sweep or scoop up and remove. Flush spill area with water. Disposal should be in accordance with all local, state and federal regulations.

MATERIAL SAFETY DATA SHEET PREPARED BY TM

NA - Not Applicable NE - Not Establishe

CHAPTER 8

THE HALOGEN FLUORIDES

8-1 PROPERTIES

Information in this chapter is applicable to chlorine trifluoride (CTF), perchloryl fluoride (PF) and chlorine pentafluoride (CPF) unless otherwise specified.

8-1.1 IDENTIFICATION. See table 8-1.

Table 8-1. Identification of Halogen Fluorides

Name	Abbreviation	Formula	Specification
Chlorine Trifluoride	CTF	ClF_3	MIL-P-81399A (reference 1) 99% ClF_3, 0.4% HF, 0.6% all other fluorides combined
Chlorine Pentafluoride	CPF	ClF_5	Commercial Spec. 99% ClF_5 MIL-P-27413 (reference 2)
Perchloryl Fluoride	PF	ClO_3F	Commercial Spec. 99% PF, 0.02% H_2O Max.

8-1.2 GENERAL APPEARANCE

8-1.2.1 CTF. CTF is a nearly colorless vapor at temperatures above 53° F. The liquid is clear and faintly greenish-yellow in color. Its odor has been described as both sweetish and pungent, similar to chlorine or mustard gas.

8-1.2.2 PF. PF gas is colorless and the liquid is clear and water-white. It has a characteristic sweet odor. At normal temperature and pressure, PF is a gas.

8-1.2.3 CPF. CPF is a colorless vapor at temperatures above 18.1° C. The liquid is clear with a very slight greenish cast.

8-1.3 CHEMICAL NATURE

8-1.3.1 CTF. CTF is a toxic oxidizing agent similar to elemental fluorine in reactivity. CTF is hypergolic with most fuels. The liquid is more active chemically than the gas.

8-1.3.2 PF. PF is a strong oxidizing agent. Under most conditions it is relatively nonreactive, but when reactive, temperature is the controlling factor in reaction rate. Explosions have been the result of mixing gaseous or liquid PF with ammonia, hydrazine and some gaseous or liquid amines.

8-1.3.3 CPF. CPF is a toxic and corrosive oxidizing agent similar to elemental fluorine in reactivity and is chemically quite similar to CTF.

8-1.3.4 Solubility. In general, CTF and CPF react with solvents rather than dissolving in them. Under normal conditions they react violently with ice or water. PF is slightly soluble in polar organic and inorganic liquid; its solubility in water at 77° F and 1 atmosphere is 0.06 percent. At room temperature it is miscible with halogens and halogenated liquids such as chlorine, chlorofluorohydrocarbons and chlorine trifluoride having about the same boiling point.

8-1.3.5 Stability. CTF and CPF are insensitive to shock, heat, and electrical sparks. PF is thermally stable up to 850°. In the presence of atmospheric water, PF hydrolyzes very slowly at room temperature to form $HClO_4$ and HF, and only slightly faster at temperatures up to 575° F. It can be stored in liquid form under pressure.

8-1.4 PHYSICAL PROPERTIES. The physical properties of CTF, CPF and PF are given in tables 8-2, 8-3, and 8-4, respectively.

A1.1 #2

Thiokol Corporation
Elkton Division
P.O. Box 241
Elkton, Maryland 21922-0241
Emergency Phone (301) 392-1000

MSDS 188
TX-M-891

MATERIAL SAFETY DATA SHEET

MSDS No. 188
Date Issued: 05/28/91

Written By: R.L. Jenkins

Approved By: J R Brown

I. Product Identification

A. Trade Name and Synonyms: ASAS DM-8 Motor, TX-M-891 (E42278)

II. Physical Data

A. Appearance and Odor: Rubber/solid propellant & pyrotechnic igniter housed in a graphite epoxy case with titanium collars and aluminum closures. No odor.

B. Volatiles: None.

III. Composition

Hazardous Ingredients	%	OSHA PEL	ACGIH TLV
A. Main Propellant Grain, TP-H-3340 (N.E.W. ~110 lbs)			
1. Ammonium Perchlorate	71	15mg/m^3 (total) 5mg/m^3 (resp.)	10mg/m^3 (total) 5mg/m^3 (resp.)
2. Aluminum Powder	18	5mg/m^3	5mg/m^3
3. Hydroxyl Terminated Polybutadiene Binder	11	NE	NE
B. Igniter Components			
1. S-75M-1 Squib	N/A	N/A	N/A
2. Boron Potassium Nitrate, 2m Pellets (N.E.W. 0.5 gm)	100	NE	NE
3. Propellant Grains (N.E.W. 49.5 gm)			
1. TP-H-3340 (5.5 gm) (For ingredients, see main Sec. III, A)			
2. TP-H-3277 (44.0 gm)			
a. Carboxy Terminated Polybutadiene Binder	*	NE	NE
b. Iron Oxide	*	10mg/m^3 (fume)	5mg/m^3 (fume)
c. Aluminum Powder	*	5mg/m^3 (TWA)	5mg/m^3 (TWA)
d. Ammonium Perchlorate	*	15mg/m^3 (total) 5mg/m^3 (resp.)	10mg/m^3 (total) 5mg/m^3 (resp.)

* = Confidential Information
NE = Not Established
N/A = Not Applicable

IV. Health Hazard Data

A. Threshold Limit Value: See Section III. Note: TLV's or PEL's only pertain to materials when in raw form. Materials are contained within the propellant by a binder system.

B. Effects of Overexposure:

1. Respiratory: None known for live motor. Decomposition products are known to cause breathing difficulty and respiratory damage.

2. Eyes: No known hazard unless burned. Decomposition products are extremely irritating.

3. Skin: Fired rocket motor residue contains hydrochloric acid and other corrosive compounds which can cause skin irritation.

4. Skin Absorption: No known hazard.

5. Ingestion: No known hazard.

6. Other: N/A

V. Emergency and First-Aid Procedures

A. Inhalation: If decomposition products are inhaled, remove victim to fresh air. Call a physician and/or emergency facility immediately.

B. Eyes: If irritated, flush with water and contact physician.

C. Skin: Thermal burns and/or exposure to decomposition products; call physician and/or emergency facility immediately.

D. Other: N/A

VI. Fire and Explosion Hazard Data

A. Flash Point: N/A

B. Explosive Limits: DOT Class B explosive (1.3 hazard symbol).

C. Extinguishing Media: Do not attempt to fight burning motor. Water, CO_2, or foam may be used to restrict spreading of fire after bulk of propellant has burned.

D. Special Fire Fighting Procedures: Propellant and igniter materials contain oxidizer and fuel. Do not fight fires involving these materials. If ignited, thrust created while burning may give this propellant uncontrollable ballistic properties. Fire fighting should be limited to preventing the spread of other fires.

E. Explosion Hazards: Static discharge, impact, friction, and pinch points between hard surfaces can initiate propellant fires and should be avoided. See VII, B.

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VII. **Reactivity Data**

A. Stability: Unstable. Conditions to avoid (stability): Propellant and ignition components become unstable when exposed to temperatures above 200°F.

B. Incompatibility (Materials to Avoid): Water-soaked propellant may liberate hydrogen gas, creating an explosive hazard.

C. Hazardous Decomposition Products: CO, CO_2, HCl, N_2, H_2, Al_2O_3, and $FeCl_2$ are theoretical exhaust products.

D. Hazardous Polymerization: Will not occur.

VIII. **Special Precautions**

A. Protective Measures:

1. Ventilation: For fired motor, provide sufficient mechanical (general and/or local exhaust) ventilation.

2. Respiratory Protection: None for cured propellant. If exposed to exhaust gases, use NIOSH/OSHA approved respirator with organic vapor/acid gas cartridges or positive-pressure airline.

3. Protective Clothing: Acid-resistant gloves should be worn when handling decomposition products. Flame-resistant lab coats or coveralls, safety glasses, and safety shoes are recommended when handling explosive devices.

B. Handling and Storage Precautions:

1. Protect motor from ignition sources, static charge buildup, mechanical shock or friction, and elevated temperatures (above 200°F).

2. Approved quantity/distance requirements for storage of explosives should be observed.

3. DoD Storage Compatibility Group C.

4. DoD Hazard Class 1.3.

C. Other Precautions: Live motors are DOT Class B explosives. Access to this motor should be limited to authorized personnel trained in the handling of pyrotechnic devices.

IX. **Environmental Protection**

A. Precautions if Component is Damaged: Damaged motor must be protected from sources of ignition. If ignition occurs in a damaged motor, unpredictable ballistic properties may be exhibited releasing pressure and spreading burning material over a wide area. Contact appropriate authorities.

B. Waste Disposal Method: Live motor is a DOT Rocket Motor, Class B explosive. EX #9012203. Dispose of in accordance with federal, state, and local regulations.

C. Fired rocket motor case should be inspected and determined propellant-free before disposal.

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